Hazardous Contaminants Program

Ontario Inventory for Specified Chlorinated and Aromatic Hydrocarbons
ARB-TDA-09-80

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P d for Air Resources Branch
tario Ministry of the Environment by
A Consulting Services Limited

March 1980

Hazardous Contaminants Program

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Ontario Inventory for Specified Chlorinated and Aromatic Hydrocarbons
ARB-TDA-09-80

THE PROVINCIAL LOTTERY TRUST FUND
PROJECT 78-011-12

Prepared for Air Resources Branch
The Ontario Ministry of the Environment by
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March 1980

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1 INTRODUCTION

This study was commissioned by the Ontario Ministry of the Environment (MOE) with the objective of preparing a province-wide quantity/location inventory and an emission/discharge inventory for specified chlorinated and aromatic hydrocarbons. The inventory will be used to evaluate potential population exposures resulting from the specified hydrocarbons.

The chemical compounds of concern in this study were

Chlorinated Hydrocarbons	Aromatic Hydrocarbons
Carbon tetrachloride	Benzene
Chloroform	Ethylbenzene
Chloroprene	Naphthalene
1,2-Dichloroethylene	Styrene
Ethylene dichloride	Toluene
Methyl chloride	Xylenes
Methylene chloride	
Tetrachloroethylene	
1,1,1-Trichloroethane	
Trichloroethylene	
Vinylidene chloride	

This document provides a brief review of Ontario uses and characteristic effects of the specified hydrocarbons, a description of the transport modes used, and a summary of emissions and discharges. The description of characteristic effects taken from the literature is directed primarily to potential effects on man and does not cover bioaccumulation, synergism, effects to the ozone layer and other possible environmental effects.

The Ontario emission/discharge inventory covers specified chemical losses to the air, water and land during manufacture, its use as a chemical intermediate, storage and transfer, repackaging for distribution, and end use. Storage and transfer losses of benzene, toluene and xylenes in gasolines were included at refinery locations; other losses of these aromatics at local filling stations or from vehicle exhausts were not included. It is important, however, to recognize that these other losses are a major source of aromatic hydrocarbon emissions, e.g. Environment Canada (1979) estimated benzene emissions of 12 975 tonnes for the year 1976 from vehicle exhausts in Ontario.

By-products resulting from specified chemical manufacture and from subsequent use of the specified chemical as a chemical intermediate were considered outside the Terms of Reference for this study, as were emissions and discharges that may occur during reclamation of the specified hydrocarbons.

2 ONTARIO INDUSTRIAL SIGNIFICANCE AND CHARACTERISTIC EFFECTS

2.1 Chlorinated Hydrocarbons

2.1.1 Carbon Tetrachloride
(Synonym: tetrachloromethane)

Two processes are used for the manufacture of carbon tetrachloride—the chlorination of carbon disulfide and the chlorination of methane or propane. Carbon disulfide conversion is the older process and produces virtually no by-products.

In 1976 Dow Chemical in Sarnia and Cornwall Chemicals in Cornwall manufactured carbon tetrachloride in Ontario. Most carbon tetrachloride in Ontario is converted to fluorochloromethanes ($CC1_2F_2$ and $CC1_3F$) by Allied Chemical at Amhertsburg and Du Pont in Maitland. Its unusually high density has made it useful as a solvent in the past for dissolving asphalt, tars, chlorinated rubber, fats, gums, waxes, rosin and paint. It has also been used as a solvent for Friedel-Crafts reactions, in dry cleaning, and for the recovery of tin from tinplating waste. However, because of its toxicity, it is no longer used as a solvent in Ontario. Its use as a grain fumigant and in fire extinguishers has also ended. In the latter case the Ontario Building Code (December 1974) does not allow the use of fire extinguishers inside buildings if they contain carbon tetrachloride.

Carbon tetrachloride is also used in minor quantities for quality control checks in Ontario chemical laboratories.

Carbon tetrachloride has a narcotic action resembling that of chloroform, but not as strong. Following exposures to high concentrations, the victim may become unconscious and, if exposure is not terminated, death can follow from respiratory failure. Exposure to lower concentrations insufficient to produce unconsciousness can result in severe gastrointestinal upset and may progress to serious kidney and hepatic damage (Sax, 1975).

2.1.2 Chloroform
(Synonyms: trichloromethane, methenyl chloride)

Although chloroform is not manufactured in Ontario, the principal process used today is via the chlorination of methane. It can also be produced by reacting acetone or ethanol with bleaching powder.

The present most important single use of chloroform is in the manufacture of chlorodifluoromethane, the principal refrigerant fluid in air conditioners. Chloroform is used for this purpose in Ontario by Allied Chemical in Amherstburg and Du Pont in Maitland. It is also used in minor quantities for quality control checks in Ontario chemical laboratories.

In the past, chloroform has been employed as an anesthetic and in the manufacture of a number of pharmaceutical preparations; e.g., analgesics, anthelmintics, carminatives, expectorants and liniments. However, its use in Canada was banned for these purposes on January 1, 1978, as stated in Canada's Food and Drug Regulations.

Chloroform causes irritation of the conjunctiva. Upon inhalation, it causes dilation of the pupils, with reduced reaction to light as well as reduced intraocular pressure. Prolonged inhalation will bring on paralysis accompanied by cardiac respiratory failure and finally death. It is also a suspected carcinogen (Sax, 1975).

2.1.3 Chloroprene
(Synonyms: 2-chloro-1, 3-butadiene, chlorobutadiene)

Although not manufactured in Ontario, chloroprene can be produced by the hydrochlorination of monovinylacetylene, a process developed by Du Pont. It can also be manufactured by the chlorination of butadiene followed by dehydrogenation of the 3, 4-dichloro-1-butene intermediate.

Chloroprene has gained commercial importance as a raw material for the manufacture of polychloroprene which is marketed under the generic name neoprene. However, it is believed that chloroprene is not used for any industrial purpose in Ontario.

Animal experiments have shown that a concentration of 250 ppm in the air is toxic, and a concentration of 75 ppm may be toxic with continued exposure. Exposure to the vapor first causes irritation of the respiratory tract followed by depression of respiration and, if exposure is continued, asphyxia. The vapor is a central nervous system depressant. Humans exposed to chloroprene have been reported to develop dermatitis, conjunctivitis, corneal necrosis, anemia, temporary loss of hair, nervousness and irritability (Sax, 1975). Chloroprene is considered dangerous when heated to decomposition or on contact with acids or acid fumes, due to highly toxic chloride fumes.

2.1.4 1,2-Dichloroethylene
(Synonyms: cis- and trans-dichloroethylene)

1,2-dichloroethylene is not manufactured in Ontario but can be produced by the reduction of 1,1,2,2-tetrachloroethane. It can also be manufactured by the direct chlorination of acetylene.

It is a low-boiling-point solvent and is therefore used for the extraction of heat-sensitive substances such as caffeine from coffee and perfume oils. It is also used as an additive to dye and lacquer solutions, as a coolant in refrigeration plants, and in the manufacture of rubber solutions. However, 1,2-dichloroethylene is not believed to have been in use in Ontario in 1976.

In high concentrations, 1,2-dichloroethylene is considered an irritant and has a narcotic effect. It has also been known to produce liver and kidney injury in experimental animals. Exposure to high concentrations of vapor can cause nausea, weakness, tremor and cramps, although recovery is usually prompt following removal from exposure (Sax, 1975).

1,2-dichloroethylene is dangerous when exposed to heat or flame and can react vigorously with oxidizing materials.

2.1.5 Ethylene Dichloride
(Synonyms: 1,2-dichloroethane, ethylene chloride)

Ethylene dichloride is manufactured by the direct chlorination of ethylene in the liquid phase in the presence of ethylene dibromide as an anticatalyst against polychlorination. Oxychlorination of ethylene or ethane as a scavenging material is also used under appropriate reaction conditions. Some ethylene dichloride is also recovered as a by-product from the production of ethylene chlorohydrin and ethyl chloride. There are two manufacturers of ethylene dichloride in Ontario: Dow Chemical in Sarnia and Ethyl Corporation in Corunna.

The principal use of this chemical in Ontario is in the production of vinyl chloride. Ethylene dichloride is also used in Ontario as a gasoline antiknock additive and in adhesives. It may also be used as an extraction solvent for spices.

Short exposures to high concentrations cause irritation of the eyes, nose and throat followed by dizziness, nausea, increasing stupor, cyanosis, rapid pulse and loss of consciousness. Chronic poisoning, where exposure has occurred over a period of several months, may cause a loss of appetite, nausea, epigastric distress, tremors, low blood sugar levels and possibly dermatitis if there has been skin contact (Sax, 1975). It has recently been identified as a suspected human carcinogen (National Institute for Occupational Safety and Health, 1978).

Ethylene dichloride emits highly toxic fumes of phosgene when heated to decomposition. It can also react vigorously with oxidizing materials.

2.1.6 Methyl Chloride
(Synonym: chloromethane)

Methyl chloride is not manufactured in Ontario but can be produced either by the chlorination of methane or by the hydrochlorination of methanol. The end product also contains other polychloro compounds such as chloroform and carbon tetrachloride as impurities.

Major uses in Ontario for this chemical are in the manufacture of antiknock compounds, butyl rubber (as a solvent), and quaternary ammonium compounds.

Methyl chloride has very slight irritant properties and may be inhaled without noticeable discomfort. It has some narcotic action, but this effect is weaker than that of chloroform. Repeated exposure to low concentrations causes damage to the central nervous system and, less frequently, to the liver, kidneys, bone marrow and cardiovascular system. Sprayed on the skin, methyl chloride produces anesthesia through freezing of the tissues as it evaporates. In exposures to high concentrations, dizziness, drowsiness, incoordination, confusion, nausea, abdominal pains, hiccups, diplopia and dimness of vision are followed by delirium, convulsions and coma (Sax, 1975).

Methyl chloride is a fire hazard when exposed to heat or flame, and when heated to decomposition it emits highly toxic chloride fumes. Methyl chloride can also react vigorously with oxidizing materials.

2.1.7 Methylene Chloride
(Synonyms: dichloromethane, methylene dichloride)

Methylene chloride is not manufactured in Ontario but can be produced by the chlorination of methane or methyl chloride. Other polychloro products are also produced as coproducts of this process.

Methylene chloride is used in Ontario mainly as a paint remover, for the removal of lacquer from metal surfaces, and in the formulation of adhesives. Other applications in Ontario include its use as a blowing agent for automotive crash pads; for industrial cleaning of engine parts in the motor transportation, railway and aircraft industries; for aerosol propellants (e.g., artificial snow, household insecticide); as an extraction solvent to isolate components from various foodstuffs, e.g., pepper extraction and caffeine from coffee beans.

This material is very dangerous to the eyes but, except for its property of inducing narcosis, it has very few other toxic effects and is the least toxic of the chloromethanes. It will not form explosive mixtures with air at ordinary temperatures. However, it can be decomposed by contact with hot surfaces and open flame, and it can then yield toxic fumes (Sax, 1975).

2.1.8 Tetrachloroethylene (Synonyms: perchloroethylene, ethylene tetrachloride, carbon dichloride)

The starting material can be methane, ethane, ethylene propane, ethylene chloride or process waste from vinyl chloride manufacture. All of these can be chlorinated to yield saturated chlorohydrocarbons, then pyrolyzed to yield mixtures which are predominantly trichloroethylene, carbon tetrachloride and tetrachloroethylene. Tetrachloroethylene is also manufactured by the chlorination of trichloroethylene to pentachloroethane and by dehydrochlorinating pentachloroethane to tetrachloroethylene. Other methods are the chlorination of acetylene and chlorination of 1,1,2,2-tetrachloroethane. Dow Chemical in Sarnia is the only manufacturer of tetrachloroethylene in Ontario.

Tetrachloroethylene is used in Ontario mainly as a dry-cleaning solvent. Du Pont (Maitland) uses tetrachloroethylene in the manufacture of fluorocarbons. It is also used in laundry aerosols and adhesives manufactured in Ontario, and for metal degreasing and textile cleaning.

While not corrosive or dangerously reactive, it can be toxic through inhalation, ingestion, or prolonged or repeated contact with the skin or mucous membrane. The symptoms of acute intoxication from this material are the results of its effects on the nervous system.

Exposures to higher concentrations than 200 ppm cause irritation, lacrimation and burning of the eyes, and irritation of the nose and throat.

This material can cause dermatitis which is preceded by a reddening and burning and more rarely a blistering of the skin (Sax, 1975). Tetrachloroethylene has also recently been identified as a suspected human carcinogen (National Institute for Occupational Safety and Health, 1978).

2.1.9 1,1,1-Trichloroethane
(Synonyms: methyl chloroform, α-trichloroethane)

Dow Chemical in Sarnia is the only manufacturer of this chemical in Ontario, which is produced by the chlorination of 1,1-dichloroethane.

1,1,1-Trichloroethane is used in Ontario mainly as a cleaning solvent for machinery such as armatures of electric motors, generators, switchgears and electronic apparatus. Other Ontario applications of this chemical include its use as a solvent in coatings, as a vehicle in adhesive compositions containing rubber, and as a surface degreasing agent on films before printing. It is also used in Ontario for glassware degreasing, in electrostatic paper coating operations and in aerosol insecticides and furniture polish.

This chemical has a narcotic effect in high concentrations (Sax, 1975) and also may have an adverse effect on the ozone layer.

2.1.10 Trichloroethylene
(Synonyms: ethinyl trichloride, ethylene trichloride)

Trichloroethylene was not manufactured in Ontario in 1976 but can be produced commercially by the oxychlorination of dichloroethylene or trichloroethane.

Most trichloroethylene in Ontario is used as a metal degreaser. It is also used in adhesives and to manufacture vinyl resins.

Inhalation of high concentrations of this material causes narcosis and anesthesia, and a form of addiction has been observed in exposed workers. Prolonged inhalation of moderate concentration causes headaches and drowsiness. Fatalities following severe, acute exposure have been attributed to ventricular fibrillation resulting in cardiac failure. There is some question as to damage to liver or other organs from chronic exposure (Sax, 1975).

Trichloroethylene is a slight fire hazard when exposed to heat or flame.

2.1.11 Vinylidene Chloride
(Synonym: 1,1-dichloroethylene)

Vinylidine chloride is not manufactured in Ontario but can be produced by the dehydrochlorination of 1,1,2-trichloroethane by agitating with an aqueous suspension of lime (calcium hydroxide) at about 50°C.

The technological importance of vinylidene chloride is in the manufacture of plastic copolymers with monomers such as vinyl chloride, acrylonitrile and methyl methacrylate. It is also used in the manufacture of 1,1,1-trichloroethane, polyvinylidene chloride, "saran" packaging, piping and filter fibers. Vinylidene chloride is not believed to have been in use in Ontario in 1976.

Details regarding the toxicity of this chemical are unknown, although it is considered highly dangerous as a result of its potential to react vigorously with oxidizing materials.

2.2 Aromatic Hydrocarbons

2.2.1 Benzene
(Synonyms: benzol, phenyl hydride, coal naphtha)

Benzene was first manufactured from the light oil recovered from coal carbonization gases. While it is still manufactured in Ontario as a by-product of coke manufacture, benzene is now produced primarily by the petroleum industry, chiefly by the solvent extraction of petroleum reformates and by the catalytic demethylation of toluene. Those companies lacking extraction equipment leave benzene in the gasoline. In Ontario, benzene is manufactured by Polysar, Petrosar, Esso Chemical and major oil refineries (Shell, Texaco and Suncor), and as a by-product by the steel companies (STELCO, DOFASCO and Algoma Steel) and Dow Chemical.

Almost all benzene manufactured and used in Ontario goes into the production of ethylbenzene for styrene. Minor amounts of benzene were used in Ontario in 1976 for aluminum alkyds and as a solvent.

Poisoning occurs most commonly through inhalation of the vapor, though benzene can penetrate the skin and thus contribute to poisoning. Exposures to high concentrations of the vapor (3,000 ppm or higher) result from accidents such as failure of equipment or spillage. Such exposures, while rare in industry, may result in acute poisoning, characterized by the narcotic action of benzene on the central nervous system. The anesthetic action of benzene is similar to that of other anesthetic gases, consisting of a preliminary stage of excitation followed by depression and eventual death through respiratory failure if exposure is continued. It is a recognized carcinogen of the blood-forming tissues (Sax, 1975).

2.2.2 Ethylbenzene

(Synonyms: ethylbenzol, phenylethane)

Ethylbenzene is produced via the alkylation of benzene with ethylene or by the fractionation of mixed xylenes. In Ontario, Dow Chemical and Polysar, both located in Sarnia manufacture ethylbenzene and use it captively for styrene. Ethylbenzene is also a component of petroleum products produced at Ontario refineries.

Exposure to the vapor causes lacrimation and irritation of the nose and throat, dizziness, and a sense of constriction of the chest. The irritant properties are sufficient to cause workers to leave an atmosphere containing 0.5 percent of the vapor (Sax, 1975).

Ethylbenzene is dangerous when exposed to heat or flame and can react vigorously with oxidizing materials.

2.2.3 Naphthalene

(Synonyms: moth flakes, white tar, tar camphor)

Domtar in Hamilton is the only company in Ontario recovering crude naphthalene from coal tar received from STELCO, DOFASCO and Algoma Steel. The crude product is shipped out of Ontario and returns as a refined product in the form of mothballs. Diamond Shamrock in Hamilton also uses naphthalene in the production of naphthalene formaldehyde.

Systematic reactions include nausea, headache, diaphoresis, hematuria, fever, anemia, liver damage, convulsions and coma (Sax, 1975).

2.2.4 Styrene
(Synonyms: vinyl benzene, phenyl ethylene, cinnamene)

The production of styrene involves the formation of ethylbenzene by the Friedel-Crafts reaction which is subsequently dehydrogenated to styrene. Ethylbenzene is also obtained by separation from gasoline reformates. Another process developed in Japan to produce styrene adds ethylene directly to benzene. The reaction is catalyzed by charcoal-supported rhenium in an oxidizing atmosphere. Monsanto, Du Pont and the U.S.S.R. hold patents to a potentially promising route involving oxidative dehydrogenation (Austin, 1974).

In Ontario, the two producers of styrene monomer are Polysar and Dow in Sarnia.

Over 50 percent of the styrene in Ontario is used for polystyrene. Other Ontario uses include acrylonitrile-butadiene-styrene (ABS), styrene-acrylonitrile (SAN), styrene butadiene rubber (SBR), polyester resins and floor finishes.

Styrene can cause severe human eye injuries. Its toxic effects are usually transient and result in irritation and possible narcosis. It is not considered a very toxic material because under ordinary conditions it does not vaporize sufficiently to reach a concentration that can kill animals such as rats and guinea pigs in a few minutes (Sax, 1975). However, styrene oxide is a suspected cancer-causing agent (Aldrich, 1980).

As a disaster hazard, styrene is considered dangerous on exposure to heat or flame. On decomposition, it emits acrid fumes and can react vigorously with oxidizing materials.

2.2.5 Toluene
(Synonyms: methyl benzene, phenyl methane, toluol)

Toluene is primarily obtained from several petroleum and petrochemical processes such as reforming, hydrocracking and steam cracking. The principal method of manufacture is by the reforming reaction. Toluene is also produced as a by-product of coke manufacture at Ontario steel plants. The Ontario companies producing toluene from petrochemical processes include Polysar, Petrosar, Esso Chemical, Suncor and Texaco. Dow Chemical also produces toluene as a by-product in the manufacture of styrene.

Toluene's primary use in Ontario is in the production of benzene and as a solvent, particularly for industrial paints, printing ink reduction and adhesives. Toluene is also present in reformate, one of the gasoline blending components of unleaded and, to a lesser degree, leaded grades of gasoline. Toluene has a high octane rating.

Other Ontario applications for toluene include its use as a solvent carrier in rubber processing, a processing agent and reactor cleanup chemical during production of phenolic resins, and as a processing agent in the manufacture of detergents.

Acute poisoning resulting from exposure to high concentrations of vapors are rare with toluene. Inhalation of 200 ppm of toluene for 8 hours may cause impairment of coordination; with higher concentrations (up to 800 ppm), effects are increased and observed in a shorter time (Sax, 1975).

2.2.6 Xylenes
(Synonym: xylols)

Xylenes are principally obtained from petroleum, although small quantities are produced from coke manufacture at Ontario steel companies. Since xylenes occur naturally only in small quantities in petroleum stock, these materials are produced by the reforming of selected naphtha streams which are very rich in naphthenes. Further extraction and distillation yields mixed xylenes. Ortho- and meta-xylenes are separated by distillation and para-xylene by crystallization. Other separation techniques applied include selective adsorption and isomerization.

Ontario companies extracting xylenes are Petrosar, Esso Chemical, Texaco and Suncor.

In Ontario, xylenes are primarily used in the manufacture of paints, resins, lacquers, enamels, and adhesives. Ortho-xylene is used in Ontario for the preparation of phthalic anhydride by BASF in Cornwall. Xylenes are also present in reformate, one of the gasoline blending components of unleaded and, to a lesser degree, leaded grades of gasoline. Another use for xylenes is in pesticides.

Xylenes are a common air contaminant and considered dangerous when exposed to heat or flame. They can also react with oxidizing materials (Sax, 1975).

3 TRANSPORT MODES FOR SPECIFIED CHEMICALS

The alternatives for shipment of hazardous materials in Ontario are by road, rail, pipeline, air or water. Responses received from the chemical industry indicated that land modes were the predominant method of shipment and that neither the airlines nor inland waterways were utilized for this purpose.

In 1976 chlorinated hydrocarbons specified in this study were shipped primarily by road, with only one manufacturer selecting the railway mode. Over 90 percent of all distributors responding to the questionnaire indicated they received and distributed shipments of chlorinated hydrocarbons by road; the remaining shipments were made by rail.

For aromatic hydrocarbons, pipeline was the most common mode of transportation for benzene and styrene, since these two aromatics were produced and consumed primarily in Sarnia. One manufacturer transported benzene by rail to Sarnia. A small portion of benzene was also shipped by road; e.g., one manufacturer in Sarnia received shipments by road from Quebec. Styrene was also transported in small quantities throughout Ontario by road.

Since toluene and xylenes have widespread usage in Ontario, the preferred mode of transportation was by road (85 percent), with rail selected as the alternative.

4 ONTARIO EMISSIONS AND DISCHARGES

4.1 Definitions

An *air emission factor* is that portion of material being manufactured, processed or used which is lost to the air from a point source; e.g., a reactor vent, and is expressed per unit of production or usage. Emissions may remain in a gaseous state in the atmosphere or may form particulates which may be transported and/or deposited some distance from the emission source. This report does not address the ultimate fate of these chemicals; it is concerned only with emissions and discharges to the point where they reach the air, water or land.

A *discharge factor* is that portion of material being manufactured, processed or used which is lost to a water body or land and is expressed per unit of production or usage. Discharges can be in the form of a solid, liquid or sludge and disposal can be via wastewater, incineration or landfill; ultimate fate beyond these points was not considered in this study.

A *fugitive emission,* in contrast to a point-source emission such as that from a reactor vent, results from an equipment leak and is characterized by a diffuse release of volatile organic carbon compounds or hydrocarbons into the atmosphere (Wallace, 1979). *Fugitive losses* include emission leaks as well as spills which may occur during manufacture, processing, storage and transfer, repackaging at distribution outlets, and ultimately in end-use applications such as painting and use of adhesives.

4.2 Methodology for Obtaining Emission/Discharge Factors

It is recognized that there are drawbacks in applying emission/discharge factors in a general manner, i.e., each plant has unique conditions. However, to fill data gaps for the Ontario situation, this methodology was utilized.

The lack of emission/discharge factors available from published sources and the quality of those factors that were available necessitated emission/discharge factors to be calculated from questionnaire responses. The resulting emission/discharge factors were based on volumes produced or consumed and emissions/discharges estimated or measured for the year 1976. Where there were only one or two respondents, a range of multipliers was used in determining emission/discharge factors for this public document to assure confidentiality and to reflect the limited accuracy of the estimate. In the latter case, a general factor is shown in Table 1, e.g. < 3 kg/ton.

The validity of a single response was checked against literature values wherever possible. In other cases there were a number of emission factors available, e.g., for storage and transfer, paint manufacture, etc. In this situation one emission factor was established by using the mean where the standard deviation was less than one half the mean; if the standard deviations was greater than one half the mean, values outside the standard deviation were dropped and the mean (final emission factor) was recalculated.

4.3 Discussion of Emission/Discharge Factors Obtained by Questionnaire

Emission/discharge factors calculated from Ontario questionnaire responses are summarized in Table 1.

The accuracy of the emission/discharge factors is a function of the basis for company calculations. Generally the large chemical manufacturers have the knowledge and equipment necessary to conduct standard tests, and therefore their estimates of emissions and discharges tend to be more accurate than the small processor. An indication of whether the emission/discharge factors are based on measurements or theoretical calculations is shown in Table 1.

Where there were comparative literature values for storage and transfer emission factors obtained by questionnaire, the questionnaire values obtained were lower in all cases except for toluene. Since the questionnaire values for storage and transfer were obtained primarily using theoretical calculations based on flow rates and vapor pressures, there is reason to believe they are generally of reasonable accuracy. This exercise also indicates that EPA storage and transfer factors for the specified chemicals are generally higher than is actually the case.

4.4 Estimate of Ontario Emissions/Discharges for 1976

Estimates of Ontario losses to air, land and water of the specified chemicals are shown in Table 2. These losses were ascertained using the following rationale.

(a) Actual emissions and discharges as provided by Ontario companies were used where available; in all other cases an emission factor was used.

(b) Where an emission factor was available from both questionnaire and literature, the higher value was used (conservative approach) unless the questionnaire value appeared unreasonably high.

(c) Where more than one literature value but no questionnaire value was available, the most recent value was used if the rationale behind the measurement or estimate appeared sound.

(d) Where no emission/discharge factor was available for use of the chemical as an intermediate, a general loss factor of 1 percent of consumption was used.

(e) Where losses were known but not quantified, e.g., sludge – twice a year; fugitive – unknown or trace, etc, one of two methods of action was taken.

    (i) Where possible, fugitive losses were estimated at one third of air emissions and wastewater discharges were assumed to be one third of total fugitive losses, based on findings by Wallace (1979).

    (ii) Where (i) above was not possible, a range between 0.05 and 1 percent of total consumption was used, depending on the questionnaire response, i.e. whether any other emissions/discharges were quantified and volumes in use.

(f) Process losses, and storage and transfer losses were included for chemical plants at oil refineries where aromatics are commercially extracted. At oil refineries not having chemical plants, only storage and transfer losses were calculated.

(g) For distributors, losses depend on whether chemicals are received in drums or by tanker loads. Emission factors up to 1 percent of annual distribution were applied to tanker loads, depending on vapor pressure.

(h) For end use, it was assumed that fugitive losses equaled consumption.

In general, Ontario emissions and discharges quantified in Table 2 include losses from manufacture, processing as a chemical intermediate, distribution and end use. However emissions from vehicle exhausts and losses at service stations are not within the scope of this study, although they are important sources of loss.

In the case of carbon tetrachloride, air emissions are expected to be considerably reduced since 1976 owing to restrictions on its use in Canada. Similarly, fugitive losses of chloroform in 1979 are estimated at $<$ 200 kg as a result of restrictions on its use as of January 1, 1978, under Canada's Food and Drug Regulations.

Other high Ontario losses indicated in Table 2 are explained primarily by end-use applications as outlined below.

Specified Chemical	End-Use Applications
Methylene chloride	Paint stripper
Tetrachloroethylene	Dry cleaning, metal cleaning
1,1,1-Trichloroethane	Metal cleaning
Trichloroethylene	Metal cleaning
Toluene	Paint, adhesives, metal cleaning, rubber processing, printing inks
Xylenes	Paint, adhesives, metal cleaning, rubber processing, pesticides, printing inks

A recent national inventory of benzene emissions (Environment Canada, 1979) has provided the only comparison of emissions for any of the specified chemicals. As part of a contribution by the Canadian Chemical Producers Association (CCPA) to the national inventory, it was estimated that Canadian benzene emissions in 1976 were approximately 1.3 percent of the benzene handled. The CCPA estimate did not include vehicle exhaust emissions (a major source of loss), steel company emissions, losses from solvent usage or discharges of benzene in wastewater and sludge. The questionnaire survey for this present survey indicated benzene emissions and discharges represented 1.6 percent of the total amount handled in Ontario in 1976. This includes losses at steel company locations, losses from solvent usage and losses at refinery locations but not at service stations or from vehicle exhausts.

4.5 Geographical Distribution of Potential Emissions/Discharges to the Ontario Environment

By satisfying at least one of the following criteria, an Ontario city or town qualified for inclusion in this inventory

- production center
- specified chemical usage $>$ 100 tonnes
- specified chemical emissions $>$ 10 tonnes
- chemical density $>$ 0.5 tonnes/km^2
- cumulative totals from any two chemicals having a chemical density of $>$0.75 tonnes/km^2.

Cities which did not qualify because of low chemical densities for all chemicals included Ancaster, Huntsville, Kapuskasing, Kirkland Lake, Newcastle, Port Colborne and Timmins. However, a number of smaller centers were identified as having high chemical densities and these centers were included for the emission/discharge inventory. These small centers are Concord, Amherstburg, Corunna, Maitland, Longford Mills, Port Hope, Tillsonburg, Vankleek Hill and Woodbridge. For all smaller centers except Vankleek Hill, losses are included in larger cities where these smaller centers have been incorporated. For example, Concord has been incorporated into the Town of Vaughan; thus all losses reported for Concord are also included under the Town of Vaughan.

Geographical distribution of estimated losses of the specified hydrocarbons for 1976 is shown in Figures 1 to 14. These losses have been aggregated from the 1976 emission/discharge inventory and were related to population centers in Ontario for potential exposure assessment. The estimated losses identified in these city centers include losses to the air, water and land during manufacture of a specified chemical, its use as a chemical intermediate, storage and transfer, repackaging for distribution and end use. Aromatic hydrocarbon emissions from vehicle exhausts and losses at service stations are not included but are a major source of loss.

It is emphasized that the emissions/discharges identified in Figures 1 to 14 are estimates only and are applicable only for the year 1976. Any extrapolation of these data to the future should incorporate changes that are continually occurring in the Canadian chemical industry as a result of technological advances, changes in demand, or evidence of chemical toxicity.

TABLE 1

EMISSION FACTORS BASED ON ONTARIO SURVEY RESULTS

Chemical	Manufacturing Process/Use/ Emission-Discharge Source	Storage and Transfer (kg/d/10^3 L)	Other Emission-Discharge Factor (kg/t)	Basis*
Carbon tetrachloride		0.095		3
	Chlorination of Hydrocarbons			
	Process air emissions			
	Fugitive emissions		< 0.004	P-6
	Discharge to water		< 5	P-2
	Solid/liquid/sludge waste		Nil	
	Chemical Intermediate – Fluorocarbons 11 and 12			
	Process air emissions		Nil	
	Fugitive emissions		< 0.002	C-3
	Discharge to water		< 1	C-2
	Solid, liquid, sludge waste		Nil	
Chloroform		< 0.15		3, 5
	Chemical Intermediate –			
	Fluorocarbon 22			
	Process air emissions		Nil	
	Fugitive emissions		< 0.005	C-3
	Discharge to water		< 2	C-2
	Solid, liquid, sludge waste		Nil	
Ethylene dichloride		< 0.03		3, 6
	Direct Chlorination of Ethylene and Vinyl Chloride Manufacture			
	Process air emissions		< 4	P-2
	Fugitive emissions		< 0.02	P-6
	Discharge to water		< 2	P-2
	Solid, liquid, sludge waste		< 4.5	P

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*Basis

P = Volume of specified chemical produced
C = Volume of specified chemical consumed
1 = Measured in accordance with government standards
2 = Other test(s) measured in accordance with standard procedures
3 = Scientific calculation, e.g., based on flow rates, vapor pressure, etc
4 = Calculation based on mass balance
5 = EPA factors for emissions or manufacturer's guarantee for equipment
6 = Not a good test

Table 1 – 2

Chemical	Manufacturing Process/Use/ Emission-Discharge Source	Storage and Transfer ($kg/d/10^3 L$)	Other Emission-Discharge Factor (kg/t)	Basis*
Ethylene dichloride (contd)	**Direct Chlorination of Ethylene and Tetraethyl Lead Manufacture**			
	Process air emissions		< 0.4	P-2
	Fugitive emissions		< 13	C-6
	Discharge to water		< 22	P-3
	Solid, liquid, sludge waste		Nil	
	Catalyst Conditioning Agent for High-Octane Gas			
	Fugitive emissions		1 000	C
Methyl chloride		< 0.04		4
	Chemical Intermediate –			
	Butyl rubber			
	Process air emissions		Nil	
	Fugitive emissions		< 500	C-4
	Discharge to water		< 50	C-4
	Solid, liquid, sludge waste		Nil	
	Tetramethyl lead (batch alloy process)			
	Transfer losses		< 5	C-4
	Process air emissions		< 10	C-4
	Fugitive emission		Nil	
	Discharge to water		Nil	
	Solid, liquid, sludge waste		Nil	
	Di-stearyl dimethylammonium chloride			
	Process air emissions		Nil	
	End product storage		< 15	C

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6 = Not a good test

Table 1 – 3

Chemical	Manufacturing Process/Use/ Emission-Discharge Source	Storage and Transfer (kg/d/10^3 L)	Other Emission-Discharge Factor (kg/t)	Basis*
Methylene chloride		< 0.7		3, 4
	Distillation of Chlorinated Methanes			
	Process air emissions		Nil	
	Fugitive emissions		< 0.2	P-6
	Discharge to water		Nil	
	Solid, liquid, sludge waste		Nil	
	Urethane Foam			
	Process air emissions		~ 330	C-6
	Fugitive emissions		Nil	
	Discharge to water		Nil	
	Solid, liquid, sludge waste		~ 670	C
	Polyurethane Moldings for Footwear			
	Process air emissions		~ 50	C-4
	Fugitive emissions			
	Discharge to water		Nil	
	Solid, liquid, sludge waste		~ 950	C
	Pharmaceuticals			
	Process air emissions		< 0.9	C-2
	Fugitive emissions		Undetectable	C-4
	Discharge to water		< 0.1	C-2
	Solid, liquid, sludge waste		< 800	
	Aerosol Formulation			
	(Artificial snow and household insecticides)			
	Process air emissions		< 3	C-4
	Fugitive emissions		< 0.3	C-6
	Discharge to water		Nil	
	Solid, liquid, sludge waste		Nil	

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*Basis

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3 = Scientific calculation, e.g., based on flow rates, vapor pressure, etc
4 = Calculation based on mass balance
5 = EPA factors for emissions or manufacturer's guarantee for equipment
6 = Not a good test

Table 1 – 4

Chemical	Manufacturing Process/Use/ Emission-Discharge Source	Storage and Transfer	Other Emission-Discharge Factor	Basis*
		(kg/d/10^3 L)	(kg/t)	
Methylene chloride (contd)	**Pepper Extraction**			
	Solid, liquid, sludge waste		1 000	C-4
	Paint Remover/Degreaser/ Adhesives Formulation			
	Process air emissions		Nil	
	Fugitive emissions		< 30	C-6
	Discharge to water		< 4	C-6
	Solid, liquid, sludge waste		< 4	C
	Paint Remover/Degreaser/ Adhesives/Aerosol End Use		1 000	C
	Industrial Cleaning			
	Fugitive emissions		442	C
	Discharge to water		382	C-4
	Solid, liquid, sludge waste		176	C
Tetrachloroethylene		0.02		3, 6
	Coproduction with CCl_4			
	Process air emissions		Undetectable	
	Fugitive emissions		< 0.08	P-6
	Discharge to water		< 1.5	P-2
	Solid, liquid, sludge waste		< 100	P
	Fluorinated Hydrocarbons			
	Process air emissions		Nil	
	Fugitive emissions		< 0.005	C-3
	Discharge to water		Nil	
	Solid, liquid, sludge waste		Nil	
	Formulation of Products for Dry Cleaning, Degreasing, Adhesives and Aerosols			
	Fugitive emissions		< 1	C-6
	Discharge to water		< 2	C-6

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*Basis

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3 = Scientific calculation, e.g., based on flow rates, vapor pressure, etc
4 = Calculation based on mass balance
5 = EPA factors for emissions or manufacturer's guarantee for equipment
6 = Not a good test

Table 1 – 5

Chemical	Manufacturing Process/Use/ Emission-Discharge Source	Storage and Transfer ($kg/d/10^3 L$)	Other Emission-Discharge Factor (kg/t)	Basis*
Tetrachloroethylene	**End Use: Dry Cleaning, Adhesives and Aerosols**			
	Losses from all sources		1 000	C
	End Use: Degreaser			
	Fugitive emissions		~ 720	C-6
	Liquid waste		~ 280	C-6
1,1,1-Trichloroethane		< 0.05		3
	Chlorination of 1,1-Dichloroethane			
	Production, storage, transfer			
	Process air emissions		< 1	P-3
	Fugitive emissions		< 0.1	P-6
	Discharge to water		< 0.5	P-2
	Solid, liquid, sludge waste		Nil	
	Formulation of Products for Degreasing, Adhesives, Aerosol Insecticides and Furniture Polish			
	Fugitive emissions		< 13	C-6
	Discharge to water		< 1.5	C-6
	Solid, liquid, sludge waste		< 13	C
	End Use: Degreaser, Adhesives, Aerosols, Furniture Polish			
	Losses from all sources		1 000	C
	End Use: Electrostatic Paper Coating			
	Process air emissions		~ 975	C-4
	Liquid waste		~ 25	C
Trichloroethylene		< 0.05		3
	Stabilized Trichloroethylene Formulation			
	Fugitive emissions only		< 0.04	C-3

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3 = Scientific calculation, e.g., based on flow rates, vapor pressure, etc
4 = Calculation based on mass balance
5 = EPA factors for emissions or manufacturer's guarantee for equipment
6 = Not a good test

Table 1 – 6

Chemical	Manufacturing Process/Use/ Emission-Discharge Source	Storage and Transfer (kg/d/10^3 L)	Other Emission-Discharge Factor (kg/t)	Basis*
Trichloroethylene (contd)	Vinyl Resins			
	Process air emissions		< 4	C-2
	Fugitive emissions		< 6.5	C-2
	Formulation of Adhesives			
	Process air emissions		< 8.5	C-4
	Fugitive emissions			
	Discharge to water		< 11	C-6
	Liquid waste		< 24	C-6
	Formulation of Degreasers			
	Fugitive emissions		< 11	6
	End Use: Degreasing			
	Process air emissions		~ 535	C-4
	Liquid/sludge waste		~ 465	C
Benzene		0.03		3
	Udex Extraction			
	Process air emissions		< 0.5	P-2
	Fugitive emissions		< 0.02	P-5, 6
	Discharge to water		< 0.1	P-3
	Solid, liquid, sludge waste		< 0.2	P
	Hydrodealkylation of Toluene			
	Process air emissions		Nil	
	Fugitive emissions		< 3.5	P-4
	Discharge to water		< 1	P-4
	Solid, liquid, sludge waste		Nil	
	By-Product of Coke Manufacturing			
	Process air emissions			
	Coke ovens			
	· coal charging		< 0.0005	Coal usage
	· door emissions		< 0.002	Coal usage

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3 = Scientific calculation, e.g., based on flow rates, vapor pressure, etc
4 = Calculation based on mass balance
5 = EPA factors for emissions or manufacturer's guarantee for equipment
6 = Not a good test

Table 1 — 7

Chemical	Manufacturing Process/Use/ Emission-Discharge Source	Storage and Transfer (kg/d/10^3 L)	Other Emission-Discharge Factor (kg/t)	Basis*
Benzene (contd)	Tar decanters		0.015	Coal usage – 5
	Tar dehydrators		0.000006	Coal usage – 5
	Solid, liquid, sludge waste		< 0.0001	Coal usage
	Coal Tar Distillation and Manufacture of Creosote			
	Process air emissions		< 60	C-3
	Discharge to water		< 0.06	C-3
	Fugitive emissions		Nil	
	Solid, liquid, sludge waste		Nil	
	Dehydrogenation of Ethylbenzene to Styrene			
	Process air emissions		< 0.5	C-3
	Fugitive emissions		< 0.8	C-6
	Discharge to water		< 2.5	C-2
	Solid, liquid, sludge waste		Nil	
	Aluminum Alkyds			
	Process air emissions		Nil	
	Fugitive emissions		< 0.2	C-3
	Discharge to water		Nil	
	Solid, liquid, sludge waste		Nil	
	Polybutadiene Synthetic Rubber			
	Process air emissions		Nil	C-4
	Fugitive emissions		~ 280	C-5
	Discharge to water		~ 720	
	Solid, liquid, sludge waste		Nil	
	Cyclohexane Oxidation			
	Process air emissions		< 40	C-3
	Fugitive emissions		Nil	
	Discharge to water		Nil	
	Solid, liquid, sludge waste		Nil	
	Rubber Processing			
	Losses from all sources		1 000	C-4

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2 = Other test(s) measured in accordance with standard procedures
3 = Scientific calculation, e.g., based on flow rates, vapor pressure, etc
4 = Calculation based on mass balance
5 = EPA factors for emissions or manufacturer's guarantee for equipment
6 = Not a good test

Table 1 – 8

Chemical	Manufacturing Process/Use/ Emission-Discharge Source	Storage and Transfer (kg/d/10^3 L)	Other Emission-Discharge Factor (kg/t)	Basis*
Benzene (contd)	**Component of High-Flash Kerosene Used in Vehicle Cylinder Block Honing Operations**			
	Losses from all sources		1 000	C-4 C-2
	End Use in Laboratory or as Degreaser			
	Losses from all sources		1 000	C
Ethylbenzene		0.02		3
	Friedel Crafts Alkylation of Benzene with Ethylene Plus Manufacture of Styrene			
	Process air emissions		< 0.1	P-3
	Fugitive emissions		< 0.8	P-4, 6
	Discharge to water		< 1.5	P-2, 4
	Solid, liquid, sludge waste		Nil	
Naphthalene		< 0.15		3
	By-Product of Coke Manufacturing			
	Process air emissions			
	Coke ovens			
	- coal charging		< 0.000014	P-2
	- door emissions		< 0.00007	P-2
	Tar decanters		< 0.0048	P-2
	Tar dehydrators		< 0.000007	P-2
	Solid, liquid, sludge waste		< 0.00003	P-2
	Coal Tar Distillation			
	Process air emissions		< 0.5	P-3
	Fugitive emissions		< 0.0009	P-3
	Discharge to water		< 0.0001	P-3
	Solid, liquid, sludge waste		< 0.09	P

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3 = Scientific calculation, e.g., based on flow rates, vapor pressure, etc
4 = Calculation based on mass balance
5 = EPA factors for emissions or manufacturer's guarantee for equipment
6 = Not a good test

Table 1 – 9

Chemical	Manufacturing Process/Use/ Emission-Discharge Source	Storage and Transfer (kg/d/10^3 L)	Other Emission-Discharge Factor (kg/t)	Basis*
Styrene		< 0.06		3
	Dehydrogenation of Ethylbenzene to Styrene			
	Process air emissions		Nil	
	Fugitive emissions		< 0.5	
	Discharge to water		< 1.5	P-2, 4
	Solid, liquid, sludge waste		< 0.7	
	Dehydrogenation of Ethylbenzene to Styrene and Manufacture of Polystyrene			
	Process air emissions		Nil	
	Fugitive emissions		< 0.008	P-6
	Discharge to water		< 3.5	P-2
	Solid, liquid, sludge waste		< 0.015	P
	S-B Rubber Emulsion Polymerization			
	Process air emissions		< 14	C-4
	Fugitive emissions			
	Discharge to water		< 26	C-4
	Solid, liquid, sludge waste		< 13	C
	S-B Latex			
	Process air emissions		< 21	C-6
	Fugitive emissions			
	Discharge to water		< 0.15	C-6
	Solid, liquid, sludge waste			
	ABS/SAN Resins			
	Process air emissions		< 55	C-2, 3, 4
	Fugitive emissions		< 0.08	C-6
	Discharge to water		< 0.25	C-2
	Solid, liquid, sludge waste		< 7	C

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3 = Scientific calculation, e.g., based on flow rates, vapor pressure, etc
4 = Calculation based on mass balance
5 = EPA factors for emissions or manufacturer's guarantee for equipment
6 = Not a goood test

Table 1 — 10

Chemical	Manufacturing Process/Use/ Emission-Discharge Source	Storage and Transfer (kg/d/10^3 L)	Other Emission-Discharge Factor (kg/t)	Basis*
Styrene (contd)	**Diluent in Polyester Resins**			
	Process air emissions		<10	C-3
	Fugitive emissions			
	Discharge to water		<6	C
	Solid, liquid, sludge waste		<50	C
	Floor Finishes (Formulation)			
	Air emissions/liquid waste		<32	C-6
	Discharge to water		Nil	
Toluene		0.1		3
	Udex Extraction			
	Process air emissions		<0.09	P-3
	Fugitive emissions		<0.007	P-5, 6
	Discharge to water		<0.08	P-3
	Solid, liquid, sludge waste		Nil	
	Hydrodealkylation of Toluene to Benzene and By-Product of Dehydrogeneation of Ethylbenzene to Styrene			
	Process air emissions		Nil	P-5
	Fugitive emissions		<13	P-4
	Discharge to water		<2	P-4
	Solid, liquid, sludge waste		Nil	
	By-Product of Dehydrogenation of Ethylbenzene to Styrene			
	Process air emissions		<3	P-3
	Fugitive emissions		<1.5	P-6
	Discharge to water		<12	P-2
	Solid, liquid, sludge waste		Nil	

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*Basis

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2 = Other test(s) measured in accordance with standard procedures
3 = Scientific calculation, e.g., based on flow rates, vapor pressure, etc
4 = Calculation based on mass balance
5 = EPA factors for emissions or manufacturer's guarantee for equipment
6 = Not a good test

Table 1 – 11

Chemical	Manufacturing Process/Use Emission-Discharge Source	Storage and Transfer (kg/d/10^3 L)	Other Emission-Discharge Factor (kg/t)	Basis*
Toluene (contd)	**By-Product of Coke Manufacturing**			
	Coke ovens			
	· coal charging		< 0.00005	Coal usage
	· door emissions		< 0.0002	Coal usage
	Tar decanters		0.0011	Coal usage – 5
	Tar dehydrators		0.000002	Coal usage – 5
	Solid, liquid, sludge waste		< 0.000007	Coal usage
	Petroleum Additives Formulation			
	Fugitive emissions		< 0.03	C-3
	Discharge to water		Nil	
	Solid, liquid, sludge waste		Nil	
	TMX Antiknock Compounds			
	Process air emissions		< 640	C-4
	Paint and Resin Manufacture			
	Process air emissions		14.8	C
	Fugivitive emissions			
	Discharge to water		1.85	C
	Solid, liquid, sludge waste		1.3	C
	Adhesives Manufacture			
	Process air emissions			
	Fugitive emissions			
	Discharge to water		Nil	
	Solid, liquid, sludge waste		< 25	C
	Phenolic Resins			
	Process air emissions		< 1	C-4
	Fugitive emissions		< 0.4	C-6
	Discharge to water		< 3	C-4
	Solid, liquid, sludge waste		< 60	C

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3 = Scientific calculation, e.g., based on flow rates, vapor pressure, etc
4 = Calculation based on mass balance
5 = EPA factors for emissions or manufacturer's guarantee for equipment
6 = Not a good test

Table 1 – 12

Chemical	Manufacturing Process/Use Emission-Discharge Source	Storage and Transfer ($kg/d/10^3$ L)	Other Emission-Discharge Factor (kg/t)	Basis*
Toluene (contd)	**Agricultural Chemical Manufacture**			
	Process air emissions		~ 260	C-3
	Fugitive emissions		Included above	
	Discharge to water		~ 10	C-6
	Solid, liquid, sludge waste		~ 730	C
	P-Amino Diphenylamine Manufacture (Rubber Chemical)			
	Process air emissions		~ 340	C-3
	Fugitive emissions		Included above	
	Discharge to water		~ 60	C-3
	Solid, liquid, sludge waste		~ 600	
	Printing Ink Consumption			
	Process emissions) Fugitive emissions, solid waste)		1 000	C-4
	Rubber Processing			
	Process emissions) Fugitive emissions)		1 000	C-4
	Electrostatic Paper Coating			1
	Process emissions) Fugitive emissions)		~ 975	C-4
	Liquid waste		~ 25	C
	Paint Application			
	Losses from all sources		1 000	C
	Adhesives – End Use			
	Fugitive emissions		1 000	C
	Degreasing			
	Losses from all sources		1 000	C

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*Basis

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2 = Other test(s) measured in accordance with standard procedures
3 = Scientific calculation, e.g., based on flow rates, vapor pressure, etc
4 = Calculation based on mass balance
5 = EPA factors for emissions or manufacturer's guarantee for equipment
6 = Not a good test

Table 1 – 13

Chemical	Manufacturing Process/use/ Emission-Discharge Source	Storage and Transfer (kg/d/10^3 L)	Other Emission-Discharge Factor (kg/t)	Basis*
Xylenes		0.004		3
	Udex Extraction			
	Process air emissions			
	Fugitive emissions		< 0.02	P-5, 6
	Discharge to water		< 0.04	P-3
	Solid, liquid, sludge waste		Nil	
	By-Product of Coke Manufacturing			
	Process air emissions			
	Coke ovens			
	- coal charging		< 0.0002	Coal usage
	- door emissions		< 0.0006	Coal usage
	Tar decanters		0.0003	Coal usage – 5
	Tar dehydrators		0.000002	Coal usage – 5
	Solid, liquid, sludge waste		< 0.0002	Coal usage
	Coal Tar Distillation			
	Process air emissions		< 220	P-3
	Fugitive emissions		Nil	
	Discharge to water		< 0.025	P-3
	Solid, liquid, sludge waste		Nil	
	Coal Tar Paints			
	Process air emissions only		< 355	C-3
	End use losses		1 000	C
	Gasoline Additives and Corrosion Inhibitors			
	Process air emissions		< 0.2	C-6
	Fugitive emissions		Nil	
	Liquid waste		< 5	C

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*Basis

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C = Volume of specified chemical consumed
1 = Measured in accordance with government standards
2 = Other test(s) measured in accordance with standard procedures
3 = Scientific calculation, e.g., based on flow rates, vapor pressure, etc
4 = Calculation based on mass balance
5 = EPA factors for emissions or manufacturer's guarantee for equipment
6 = Not a good test

Table 1 — 14

Chemical	Manufacturing Process/Use Emission-Discharge Source	Storage and Transfer (kg/d/10^3 L)	Other Emission-Discharge Factor (kg/t)	Basis*
Xylenes (contd)	**Phthalic Anhydride**			
	Process air emissions		Nil	C
	Fugitive emissions			
	Discharge to water		Nil	
	Solid, liquid, sludge waste		Nil	
	Paint and Resin Manufacture			
	Process air emissions		19.25	C
	Fugitive emissions			
	Discharge to water		2.7	C
	Solid, liquid, sludge waste		2.7	C
	Adhesives Manufacture			
	Process air emissions)	Assumed similar to toluene		
	Fugitive emissions)			
	Discharge to water)			
	Solid, liquid, sludge waste)			
	Pesticide Formulation			
	Process air emissions		<0.08	C-4
	Fugitive emissions		Nil	
	Discharge to water		Nil	
	Solid, liquid, sludge waste		Nil	
	Furniture Polish			
	Process air emissions			
	Fugitive emissions		<0.4	C-6
	Discharge to water		Nil	
	Solid, liquid, sludge waste		Nil	
	Rubber Processing			
	Losses from all sources		1 000	C
	End Use: Paint Application, Adhesives, Degreasing, Pesticide Application, Printing Ink			
	Losses from all sources		1 000	C

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*Basis

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C = Volume of specified chemical consumed
1 = Measured in accordance with government standards
2 = Other test(s) measured in accordance with standard procedures
3 = Scientific calculation, e.g., based on flow rates, vapor pressure, etc
4 = Calculation based on mass balance
5 = EPA factors for emissions or manufacturer's guarantee for equipment
6 = Not a good test

DESCRIPTION	CARBON TETRACHLORIDE	CHLOROFORM	ETHYLENE DICHLORIDE	METHYL CHLORIDE	METHYLENE CHLORIDE	TETRACHLORO-ETHYLENE	1,1,1, TRICHLORO-ETHANE	TRICHLORO-ETHYLENE	BENZENE	ETHYL-BENZENE	NAPHTHALENE	STYRENE	TOLUENE	XYLENES
	TONNES/% OF TOTAL													
AIR EMISSIONS	6854.0/94.9		307.3/30.3	277.0/32.8	153.6/2.8	6755.0/74.4	5490.8/78.6	3725.2/63.4	167.8 /4.0	5.0 /1.0	35.0/15.0	663.9/25.0	9921.0/29.0	280.0/0.5
FUGITIVE LOSSES	1.0 /0.01	40.14 /85.0	2.6 /0.3	503.4/59.7	5077.3/93.0	950.2/10.5			1114.7 /28.0	132.5 /22.0	192.0/83.0	53.0 /2.0	23396/68.3	48323/92.9
WASTEWATER DISCHARGES	136.3/1.9	1.24 /3.0	305.1/30.1	49.3 /5.9	5.6 /0.1	25.2 /0.3	3.9 /<0.1	13.6 /0.2	983.7/25.0	175.2/30.0	0.3 /0.1	1198.0/45.0	203.0/0.6	37.0/0.07
SOLID/LIQUID/SLUDGE WASTE	2.2 /0.03		364.0/35.9		186.0/3.4	1334.4/14.7	1434.9/20.6	2129.2/36.2	(d) 943.2/24.0		2.0 /1.0	603.0/23.0	537.0/1.6	3341.0/6.4
STORAGE AND TRANSFER	232.2/3.2	5.84 /12.0	35.2 /3.5	13.1 / 1.6	38.9 /0.7	11.0 /0.1	52.3 /0.7	13.9 /0.2	747.9 /19.0	268.7/47.0	2.4 /1.0	144.0/5.0	185.0 /0.5	52.0/0.1
TOTAL ONTARIO EMISSIONS/DISCHARGES	7225.7	47.22	1014.2	842.8	5461.4	9075.8	6981.9	5881.9	(e) 3957.3	591.6	231.7	2662.1	(e) 34242.0	(e) 52033.0
(a) LOSSES AS % OF AMOUNT HANDLED	24.9	1.7	0.9	37.7	73.5	(b) 70.5	(b) 66.5	(c) 78.4	1.6	0.3	1.3	1.6	25.3	50.2

(a) AMOUNT HANDLED = ONTARIO PRODUCTION + IMPORTS

(b) ACTUAL LOSSES IN ONTARIO REPRESENT 100 % OF USAGE, REMAINING AMOUNT HANDLED IS EXPORTED

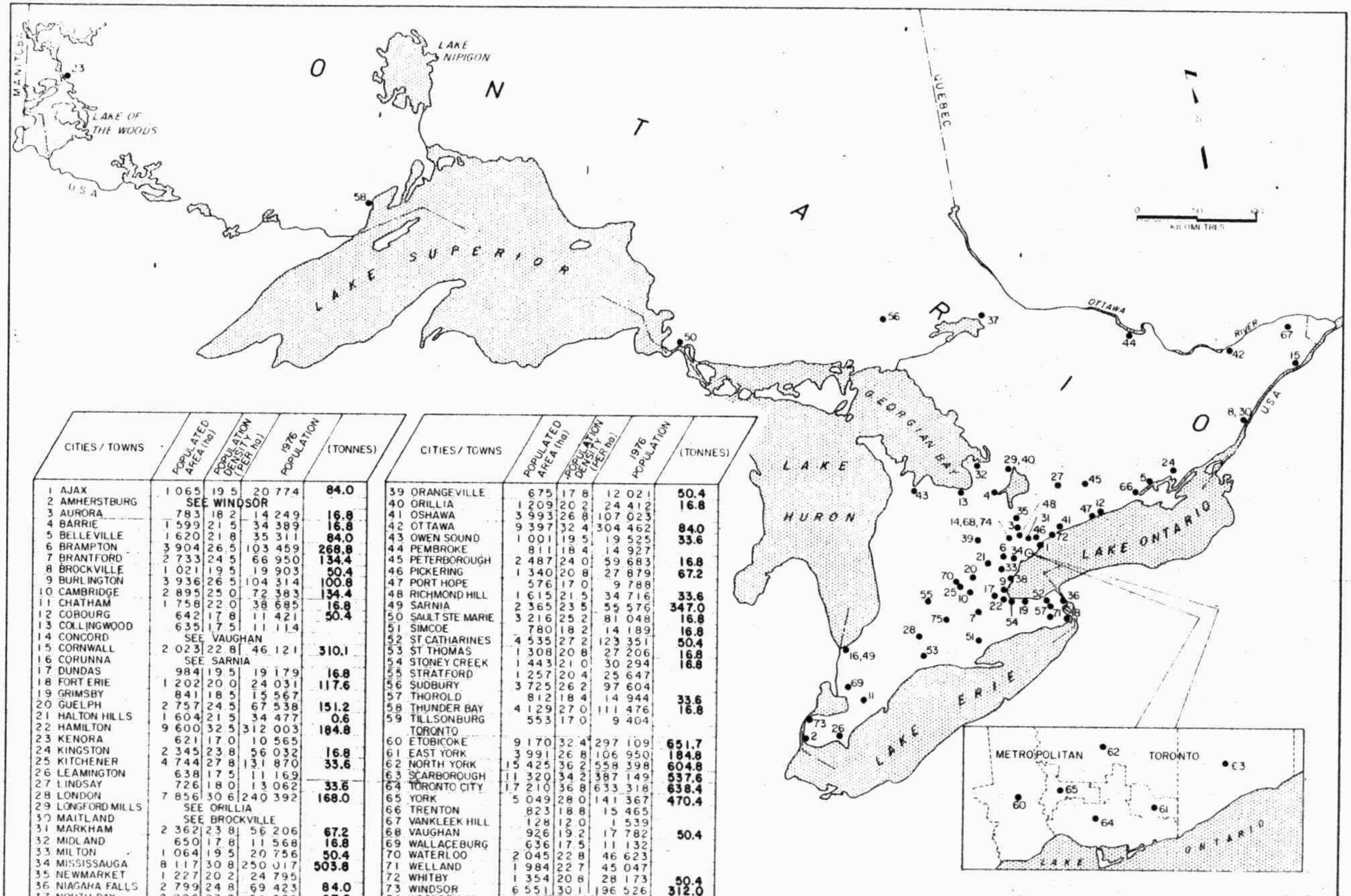
(c) ACTUAL LOSSES IN ONTARIO REPRESENT 99.2 % OF USAGE, REMAINING AMOUNT HANDLED IS PRIMARILY EXPORTED

(d) PRIMARILY AS BY-PRODUCT OF COKING

(e) DOES NOT INCLUDE EMISSIONS FROM VEHICLE EXHAUSTS. BASED ON RECENT DATA PUBLISHED BY ENVIRONMENT CANADA (1979) ONTARIO VEHICLE EXHAUST EMISSIONS WOULD ADD 12,975 TONNES TO THE ABOVE FOR BENZENE

TABLE 2

ESTIMATED 1976 ONTARIO EMISSIONS AND DISCHARGES FOR 14 CHLORINATED AND AROMATIC HYDROCARBONS



CITIES / TOWNS	POPULATED AREA (ha)	POPULATION DENSITY (PER ha)	1976 POPULATION	(TONNES)
1 AJAX	1 065	19.5	20 774	84.0
2 AMHERSTBURG	SEE WINDSOR			
3 AURORA	783	18.2	14 249	16.8
4 BARRIE	1 599	21.5	34 389	16.8
5 BELLEVILLE	1 620	21.8	35 311	84.0
6 BRAMPTON	3 904	26.5	103 459	268.8
7 BRANTFORD	2 733	24.5	66 950	134.4
8 BROCKVILLE	1 021	19.5	19 903	50.4
9 BURLINGTON	3 936	26.5	104 314	100.8
10 CAMBRIDGE	2 895	25.0	72 383	134.4
11 CHATHAM	1 758	22.0	38 685	16.8
12 COBOURG	642	17.8	11 421	50.4
13 COLLINGWOOD	635	17.5	11 114	
14 CONCORD	SEE VAUGHAN			
15 CORNWALL	2 023	22.8	46 121	310.1
16 CORUNNA	SEE SARNIA			
17 DUNDAS	984	19.5	19 179	16.8
18 FORT ERIE	1 202	20.0	24 031	117.6
19 GRIMSBY	841	18.5	15 567	
20 GUELPH	2 757	24.5	67 538	151.2
21 HALTON HILLS	1 604	21.5	34 477	0.6
22 HAMILTON	9 600	32.5	312 003	184.8
23 KENORA	621	17.0	10 565	
24 KINGSTON	2 345	23.8	56 032	16.8
25 KITCHENER	4 744	27.8	131 870	33.6
26 LEAMINGTON	638	17.5	11 169	
27 LINDSAY	726	18.0	13 062	33.6
28 LONDON	7 856	30.6	240 392	168.0
29 LONGFORD MILLS	SEE ORILLIA			
30 MAITLAND	SEE BROCKVILLE			
31 MARKHAM	2 362	23.8	56 206	67.2
32 MIDLAND	650	17.8	11 568	16.8
33 MILTON	1 064	19.5	20 756	50.4
34 MISSISSAUGA	8 117	30.8	250 017	503.8
35 NEWMARKET	1 227	20.2	24 795	
36 NIAGARA FALLS	2 799	24.8	69 423	84.0
37 NORTH BAY	2 226	23.2	51 639	67.2
38 OAKVILLE	2 780	24.8	68 950	117.6

CITIES / TOWNS	POPULATED AREA (ha)	POPULATION DENSITY (PER ha)	1976 POPULATION	(TONNES)
39 ORANGEVILLE	675	17.8	12 021	50.4
40 ORILLIA	1 209	20.2	24 412	16.8
41 OSHAWA	3 993	26.8	107 023	
42 OTTAWA	9 397	32.4	304 462	84.0
43 OWEN SOUND	1 001	19.5	19 525	33.6
44 PEMBROKE	811	18.4	14 927	
45 PETERBOROUGH	2 487	24.0	59 683	16.8
46 PICKERING	1 340	20.8	27 879	67.2
47 PORT HOPE	576	17.0	9 788	
48 RICHMOND HILL	1 615	21.5	34 716	33.6
49 SARNIA	2 365	23.5	55 576	347.0
50 SAULT STE MARIE	3 216	25.2	81 048	16.8
51 SIMCOE	780	18.2	14 189	16.8
52 ST CATHARINES	4 535	27.2	123 351	50.4
53 ST THOMAS	1 308	20.8	27 206	16.8
54 STONEY CREEK	1 443	21.0	30 294	16.8
55 STRATFORD	1 257	20.4	25 647	
56 SUDBURY	3 725	26.2	97 604	
57 THOROLD	812	18.4	14 944	33.6
58 THUNDER BAY	4 129	27.0	111 476	16.8
59 TILLSONBURG	553	17.0	9 404	
TORONTO				
60 ETOBICOKE	9 170	32.4	297 109	651.7
61 EAST YORK	3 991	26.8	106 950	184.8
62 NORTH YORK	15 425	36.2	558 398	604.8
63 SCARBOROUGH	11 320	34.2	387 149	537.6
64 TORONTO CITY	17 210	36.8	633 318	638.4
65 YORK	5 049	28.0	141 367	470.4
66 TRENTON	823	18.8	15 465	
67 VANKLEEK HILL	128	12.0	1 539	
68 VAUGHAN	926	19.2	17 782	50.4
69 WALLACEBURG	636	17.5	11 132	
70 WATERLOO	2 045	22.8	46 623	
71 WELLAND	1 984	22.7	45 047	
72 WHITBY	1 354	20.8	28 173	50.4
73 WINDSOR	6 551	30.1	196 526	312.0
74 WOODBRIDGE	SEE VAUGHAN			
75 WOODSTOCK	1 306	20.5	26 779	33.6

FIG 1

GEOGRAPHIC DISTRIBUTION OF EMISSIONS AND DISCHARGES,
POTENTIAL POPULATION EXPOSURES

CARBON TETRACHLORIDE

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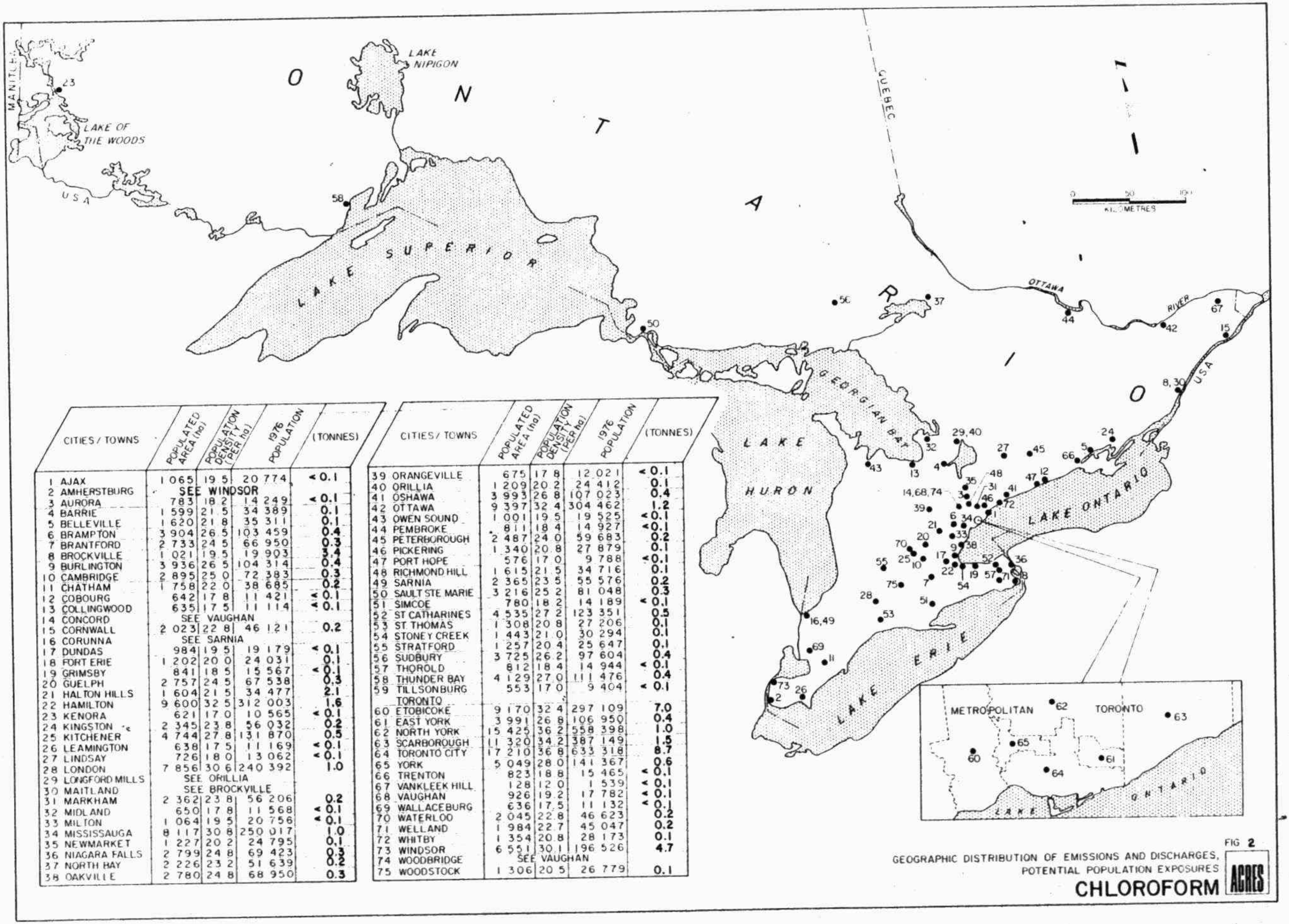

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5 BELLEVILLE	1 620	21.8	35 311	0.1
6 BRAMPTON	3 904	26.5	103 459	0.4
7 BRANTFORD	2 733	24.5	66 950	0.3
8 BROCKVILLE	1 021	19.5	19 903	3.4
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10 CAMBRIDGE	2 895	25.0	72 383	0.3
11 CHATHAM	1 758	22.0	38 685	0.2
12 COBOURG	642	17.8	11 421	< 0.1
13 COLLINGWOOD	635	17.5	11 114	< 0.1
14 CONCORD	SEE VAUGHAN			
15 CORNWALL	2 023	22.8	46 121	0.2
16 CORUNNA	SEE SARNIA			
17 DUNDAS	984	19.5	19 179	< 0.1
18 FORT ERIE	1 202	20.0	24 031	0.1
19 GRIMSBY	841	18.5	15 567	< 0.1
20 GUELPH	2 757	24.5	67 538	0.3
21 HALTON HILLS	1 604	21.5	34 477	2.1
22 HAMILTON	9 600	32.5	312 003	1.6
23 KENORA	621	17.0	10 565	< 0.1
24 KINGSTON	2 345	23.8	56 032	0.2
25 KITCHENER	4 744	27.8	131 870	0.5
26 LEAMINGTON	638	17.5	11 169	< 0.1
27 LINDSAY	726	18.0	13 062	< 0.1
28 LONDON	7 856	30.6	240 392	1.0
29 LONGFORD MILLS	SEE ORILLIA			
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32 MIDLAND	650	17.8	11 568	< 0.1
33 MILTON	1 064	19.5	20 756	< 0.1
34 MISSISSAUGA	8 117	30.8	250 017	1.0
35 NEWMARKET	1 227	20.2	24 795	0.1
36 NIAGARA FALLS	2 799	24.8	69 423	0.3
37 NORTH BAY	2 226	23.2	51 639	0.2
38 OAKVILLE	2 780	24.8	68 950	0.3

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43 OWEN SOUND	1 001	19.5	19 525	< 0.1
44 PEMBROKE	811	18.4	14 927	< 0.1
45 PETERBOROUGH	2 487	24.0	59 683	0.2
46 PICKERING	1 340	20.8	27 879	0.1
47 PORT HOPE	576	17.0	9 788	< 0.1
48 RICHMOND HILL	1 615	21.5	34 716	0.1
49 SARNIA	2 365	23.5	55 576	0.2
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51 SIMCOE	780	18.2	14 189	< 0.1
52 ST CATHARINES	4 535	27.2	123 351	0.5
53 ST THOMAS	1 308	20.8	27 206	0.1
54 STONEY CREEK	1 443	21.0	30 294	0.1
55 STRATFORD	1 257	20.4	25 647	0.1
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57 THOROLD	812	18.4	14 944	< 0.1
58 THUNDER BAY	4 129	27.0	111 476	0.4
59 TILLSONBURG	553	17.0	9 404	< 0.1
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66 TRENTON	823	18.8	15 465	< 0.1
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71 WELLAND	1 984	22.7	45 047	0.2
72 WHITBY	1 354	20.8	28 173	0.1
73 WINDSOR	6 551	30.1	196 526	4.7
74 WOODBRIDGE	SEE VAUGHAN			
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FIG 2

GEOGRAPHIC DISTRIBUTION OF EMISSIONS AND DISCHARGES, POTENTIAL POPULATION EXPOSURES

CHLOROFORM

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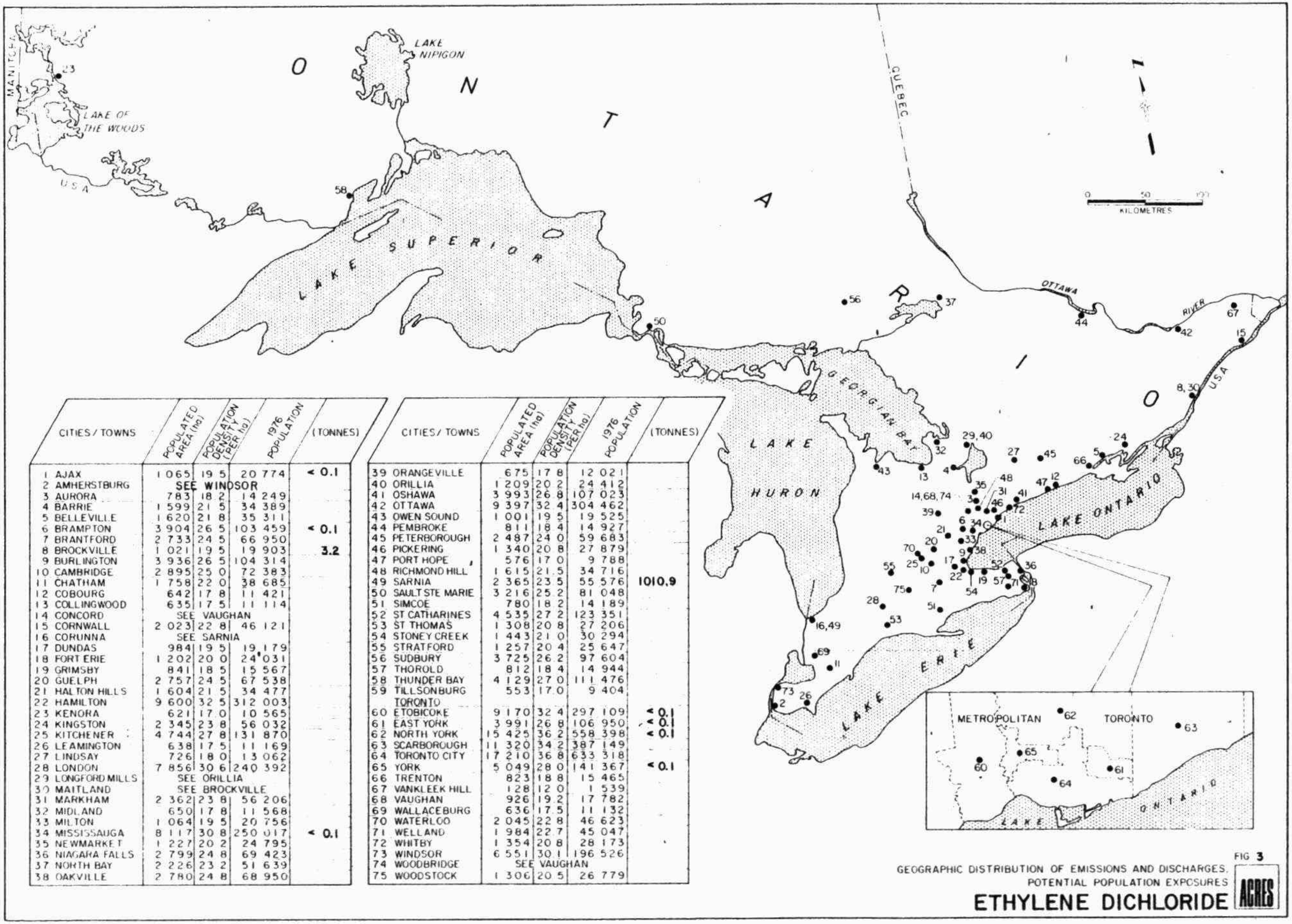

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7 BRANTFORD	2 733	24.5	66 950	
8 BROCKVILLE	1 021	19.5	19 903	3.2
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FIG 3

GEOGRAPHIC DISTRIBUTION OF EMISSIONS AND DISCHARGES.
POTENTIAL POPULATION EXPOSURES

ETHYLENE DICHLORIDE

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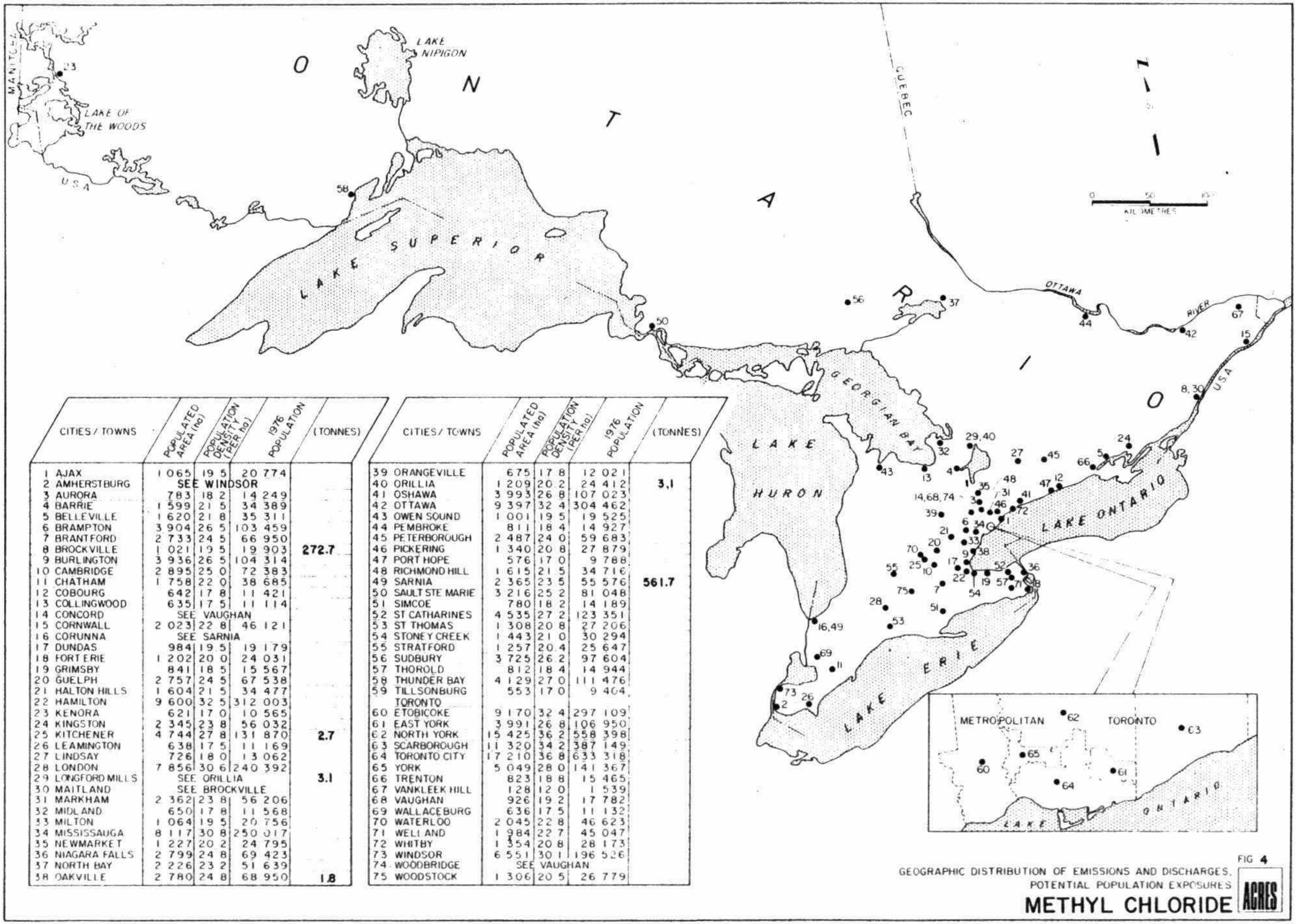

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FIG 4

GEOGRAPHIC DISTRIBUTION OF EMISSIONS AND DISCHARGES, POTENTIAL POPULATION EXPOSURES

METHYL CHLORIDE

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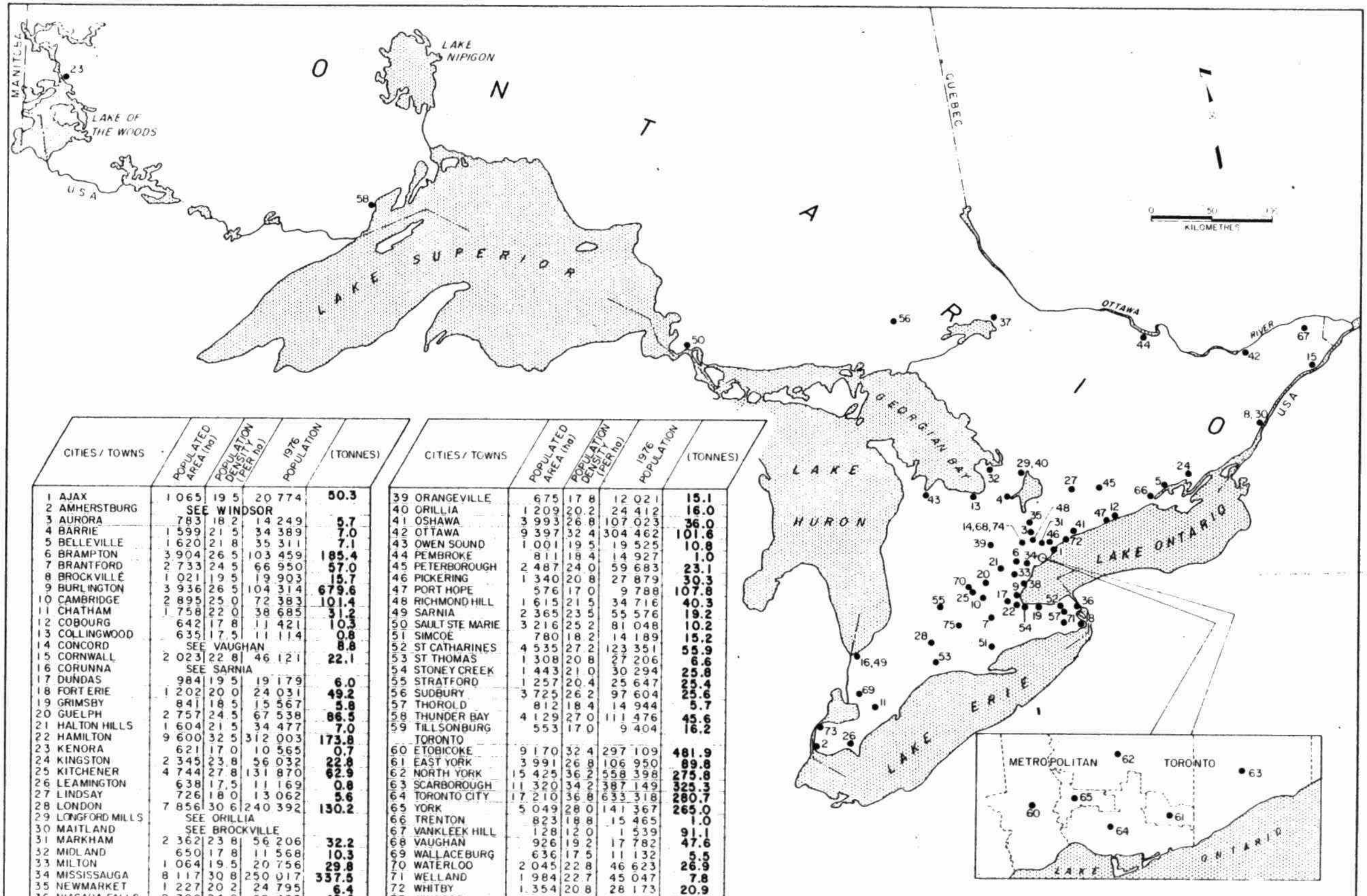

CITIES / TOWNS	POPULATED AREA (ha)	POPULATION DENSITY (PER ha)	1976 POPULATION	(TONNES)
1 AJAX	1 065	19 5	20 774	50.3
2 AMHERSTBURG	SEE WINDSOR			
3 AURORA	783	18 2	14 249	5.7
4 BARRIE	1 599	21 5	34 389	7.0
5 BELLEVILLE	1 620	21 8	35 311	7.1
6 BRAMPTON	3 904	26 5	103 459	185.4
7 BRANTFORD	2 733	24 5	66 950	57.0
8 BROCKVILLE	1 021	19 5	19 903	15.7
9 BURLINGTON	3 936	26 5	104 314	679.6
10 CAMBRIDGE	2 895	25 0	72 383	101.4
11 CHATHAM	1 758	22 0	38 685	31.2
12 COBOURG	642	17 8	11 421	10.3
13 COLLINGWOOD	635	17.5	11 114	0.8
14 CONCORD	SEE VAUGHAN			8.8
15 CORNWALL	2 023	22 8	46 121	22.1
16 CORUNNA	SEE SARNIA			
17 DUNDAS	984	19 5	19 179	6.0
18 FORT ERIE	1 202	20 0	24 031	49.2
19 GRIMSBY	841	18 5	15 567	5.8
20 GUELPH	2 757	24 5	67 538	86.5
21 HALTON HILLS	1 604	21 5	34 477	7.0
22 HAMILTON	9 600	32 5	312 003	173.8
23 KENORA	621	17 0	10 565	0.7
24 KINGSTON	2 345	23.8	56 032	22.8
25 KITCHENER	4 744	27 8	131 870	62.9
26 LEAMINGTON	638	17.5	11 169	0.8
27 LINDSAY	726	18 0	13 062	5.6
28 LONDON	7 856	30 6	240 392	130.2
29 LONGFORD MILLS	SEE ORILLIA			
30 MAITLAND	SEE BROCKVILLE			
31 MARKHAM	2 362	23 8	56 206	32.2
32 MIDLAND	650	17 8	11 568	10.3
33 MILTON	1 064	19.5	20 756	29.8
34 MISSISSAUGA	8 117	30 8	250 017	337.5
35 NEWMARKET	1 227	20 2	24 795	6.4
36 NIAGARA FALLS	2 799	24 8	69 423	42.6
37 NORTH BAY	2 226	23 2	51 639	17.7
38 OAKVILLE	2 780	24 8	68 950	123.2
39 ORANGEVILLE	675	17 8	12 021	15.1
40 ORILLIA	1 209	20.2	24 412	16.0
41 OSHAWA	3 993	26 8	107 023	36.0
42 OTTAWA	9 397	32 4	304 462	101.6
43 OWEN SOUND	1 001	19 5	19 525	10.8
44 PEMBROKE	811	18 4	14 927	1.0
45 PETERBOROUGH	2 487	24 0	59 683	23.1
46 PICKERING	1 340	20 8	27 879	30.3
47 PORT HOPE	576	17 0	9 788	107.8
48 RICHMOND HILL	1 615	21 5	34 716	40.3
49 SARNIA	2 365	23 5	55 576	19.2
50 SAULT STE MARIE	3 216	25 2	81 048	10.2
51 SIMCOE	780	18 2	14 189	15.2
52 ST CATHARINES	4 535	27 2	123 351	55.9
53 ST THOMAS	1 308	20 8	27 206	6.6
54 STONEY CREEK	1 443	21 0	30 294	25.8
55 STRATFORD	1 257	20.4	25 647	25.4
56 SUDBURY	3 725	26 2	97 604	25.6
57 THOROLD	812	18 4	14 944	5.7
58 THUNDER BAY	4 129	27 0	111 476	45.6
59 TILLSONBURG	553	17 0	9 404	16.2
TORONTO				
60 ETOBICOKE	9 170	32 4	297 109	481.9
61 EAST YORK	3 991	26 8	106 950	89.8
62 NORTH YORK	15 425	36 2	558 398	275.8
63 SCARBOROUGH	11 320	34 2	387 149	325.3
64 TORONTO CITY	17 210	36 8	633 318	280.7
65 YORK	5 049	28 0	141 367	265.0
66 TRENTON	823	18 8	15 465	1.0
67 VANKLEEK HILL	128	12 0	1 539	91.1
68 VAUGHAN	926	19 2	17 782	47.6
69 WALLACEBURG	636	17 5	11 132	5.5
70 WATERLOO	2 045	22 8	46 623	26.9
71 WELLAND	1 984	22.7	45 047	7.8
72 WHITBY	1 354	20 8	28 173	20.9
73 WINDSOR	6 551	30 1	196 526	296.7
74 WOODBRIDGE	SEE VAUGHAN			37.6
75 WOODSTOCK	1 306	20 5	26 779	49.2

FIG 5

GEOGRAPHIC DISTRIBUTION OF EMISSIONS AND DISCHARGES,
POTENTIAL POPULATION EXPOSURES
METHYLENE CHLORIDE

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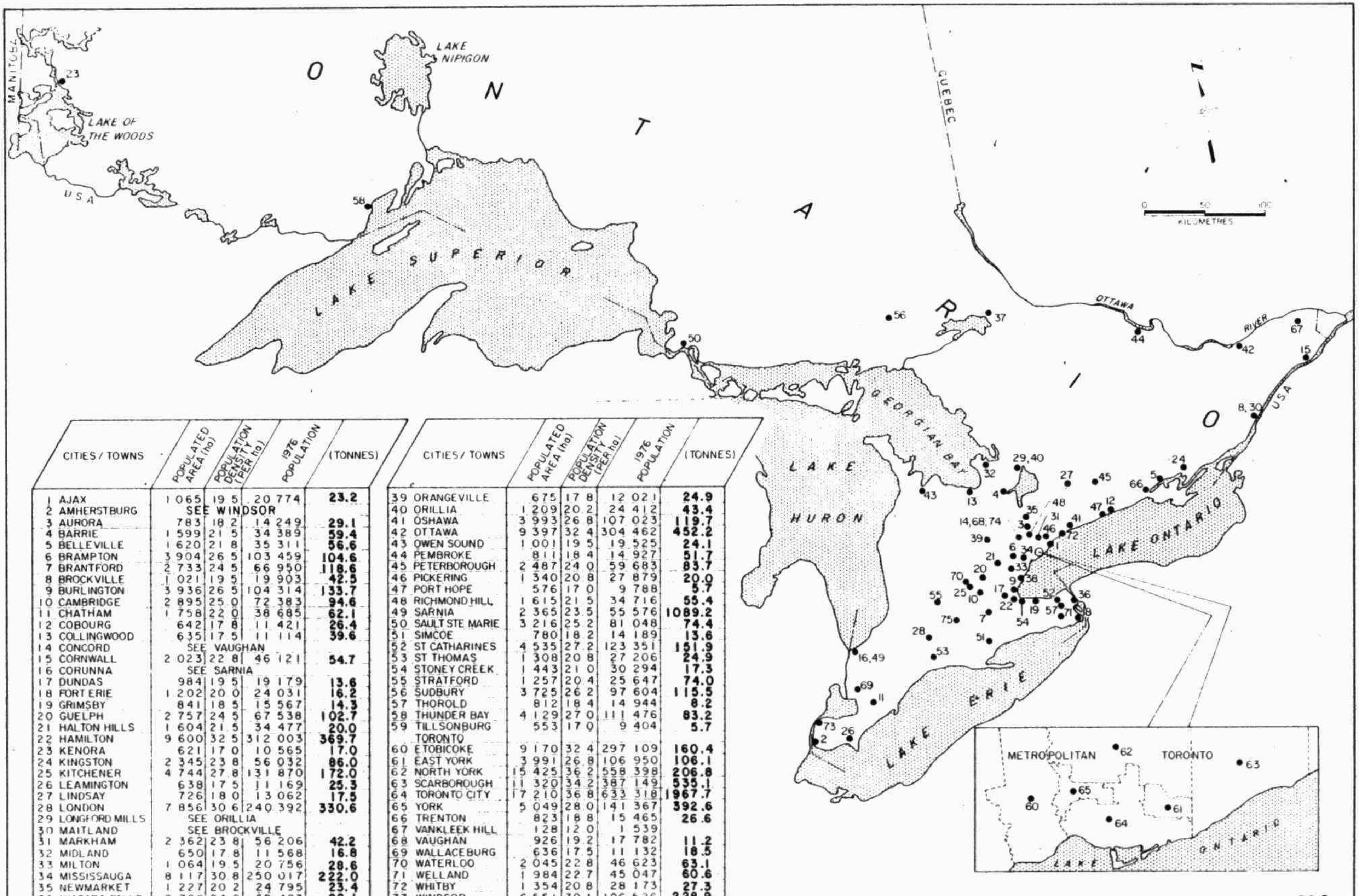

	CITIES / TOWNS	POPULATED AREA (ha)	POPULATION DENSITY (PER ha)	1976 POPULATION	(TONNES)
1	AJAX	1 065	19.5	20 774	**23.2**
2	AMHERSTBURG	SEE WINDSOR			
3	AURORA	783	18.2	14 249	**29.1**
4	BARRIE	1 599	21.5	34 389	**59.4**
5	BELLEVILLE	1 620	21.8	35 311	**56.6**
6	BRAMPTON	3 904	26.5	103 459	**104.6**
7	BRANTFORD	2 733	24.5	66 950	**118.6**
8	BROCKVILLE	1 021	19.5	19 903	**42.5**
9	BURLINGTON	3 936	26.5	104 314	**133.7**
10	CAMBRIDGE	2 895	25.0	72 383	**94.6**
11	CHATHAM	1 758	22.0	38 685	**62.1**
12	COBOURG	642	17.8	11 421	**26.4**
13	COLLINGWOOD	635	17.5	11 114	**39.6**
14	CONCORD	SEE VAUGHAN			
15	CORNWALL	2 023	22.8	46 121	**54.7**
16	CORUNNA	SEE SARNIA			
17	DUNDAS	984	19.5	19 179	**13.6**
18	FORT ERIE	1 202	20.0	24 031	**16.2**
19	GRIMSBY	841	18.5	15 567	**14.3**
20	GUELPH	2 757	24.5	67 538	**102.7**
21	HALTON HILLS	1 604	21.5	34 477	**20.0**
22	HAMILTON	9 600	32.5	312 003	**369.7**
23	KENORA	621	17.0	10 565	**17.0**
24	KINGSTON	2 345	23.8	56 032	**86.0**
25	KITCHENER	4 744	27.8	131 870	**172.0**
26	LEAMINGTON	638	17.5	11 169	**25.3**
27	LINDSAY	726	18.0	13 062	**17.5**
28	LONDON	7 856	30.6	240 392	**330.6**
29	LONGFORD MILLS	SEE ORILLIA			
30	MAITLAND	SEE BROCKVILLE			
31	MARKHAM	2 362	23.8	56 206	**42.2**
32	MIDLAND	650	17.8	11 568	**16.8**
33	MILTON	1 064	19.5	20 756	**28.6**
34	MISSISSAUGA	8 117	30.8	250 017	**222.0**
35	NEWMARKET	1 227	20.2	24 795	**23.4**
36	NIAGARA FALLS	2 799	24.8	69 423	**98.1**
37	NORTH BAY	2 226	23.2	51 639	**59.6**
38	OAKVILLE	2 780	24.8	68 950	**90.5**

	CITIES / TOWNS	POPULATED AREA (ha)	POPULATION DENSITY (PER ha)	1976 POPULATION	(TONNES)
39	ORANGEVILLE	675	17.8	12 021	**24.9**
40	ORILLIA	1 209	20.2	24 412	**43.4**
41	OSHAWA	3 993	26.8	107 023	**119.7**
42	OTTAWA	9 397	32.4	304 462	**452.2**
43	OWEN SOUND	1 001	19.5	19 525	**24.1**
44	PEMBROKE	811	18.4	14 927	**51.7**
45	PETERBOROUGH	2 487	24.0	59 683	**83.7**
46	PICKERING	1 340	20.8	27 879	**20.0**
47	PORT HOPE	576	17.0	9 788	**5.7**
48	RICHMOND HILL	1 615	21.5	34 716	**55.4**
49	SARNIA	2 365	23.5	55 576	**1089.2**
50	SAULT STE MARIE	3 216	25.2	81 048	**74.4**
51	SIMCOE	780	18.2	14 189	**13.6**
52	ST CATHARINES	4 535	27.2	123 351	**151.9**
53	ST THOMAS	1 308	20.8	27 206	**24.9**
54	STONEY CREEK	1 443	21.0	30 294	**17.3**
55	STRATFORD	1 257	20.4	25 647	**74.0**
56	SUDBURY	3 725	26.2	97 604	**115.5**
57	THOROLD	812	18.4	14 944	**8.2**
58	THUNDER BAY	4 129	27.0	111 476	**83.2**
59	TILLSONBURG	553	17.0	9 404	**5.7**
	TORONTO				
60	ETOBICOKE	9 170	32.4	297 109	**160.4**
61	EAST YORK	3 991	26.8	106 950	**106.1**
62	NORTH YORK	15 425	36.2	558 398	**206.8**
63	SCARBOROUGH	11 320	34.2	387 149	**535.1**
64	TORONTO CITY	17 210	36.8	633 318	**1967.7**
65	YORK	5 049	28.0	141 367	**392.6**
66	TRENTON	823	18.8	15 465	**26.6**
67	VANKLEEK HILL	128	12.0	1 539	
68	VAUGHAN	926	19.2	17 782	**11.2**
69	WALLACEBURG	636	17.5	11 132	**18.5**
70	WATERLOO	2 045	22.8	46 623	**63.1**
71	WELLAND	1 984	22.7	45 047	**60.6**
72	WHITBY	1 354	20.8	28 173	**27.3**
73	WINDSOR	6 551	30.1	196 526	**228.9**
74	WOODBRIDGE	SEE VAUGHAN			
75	WOODSTOCK	1 306	20.5	26 779	**33.8**

FIG. **6**

GEOGRAPHIC DISTRIBUTION OF EMISSIONS AND DISCHARGES,
POTENTIAL POPULATION EXPOSURES

TETRACHLOROETHYLENE

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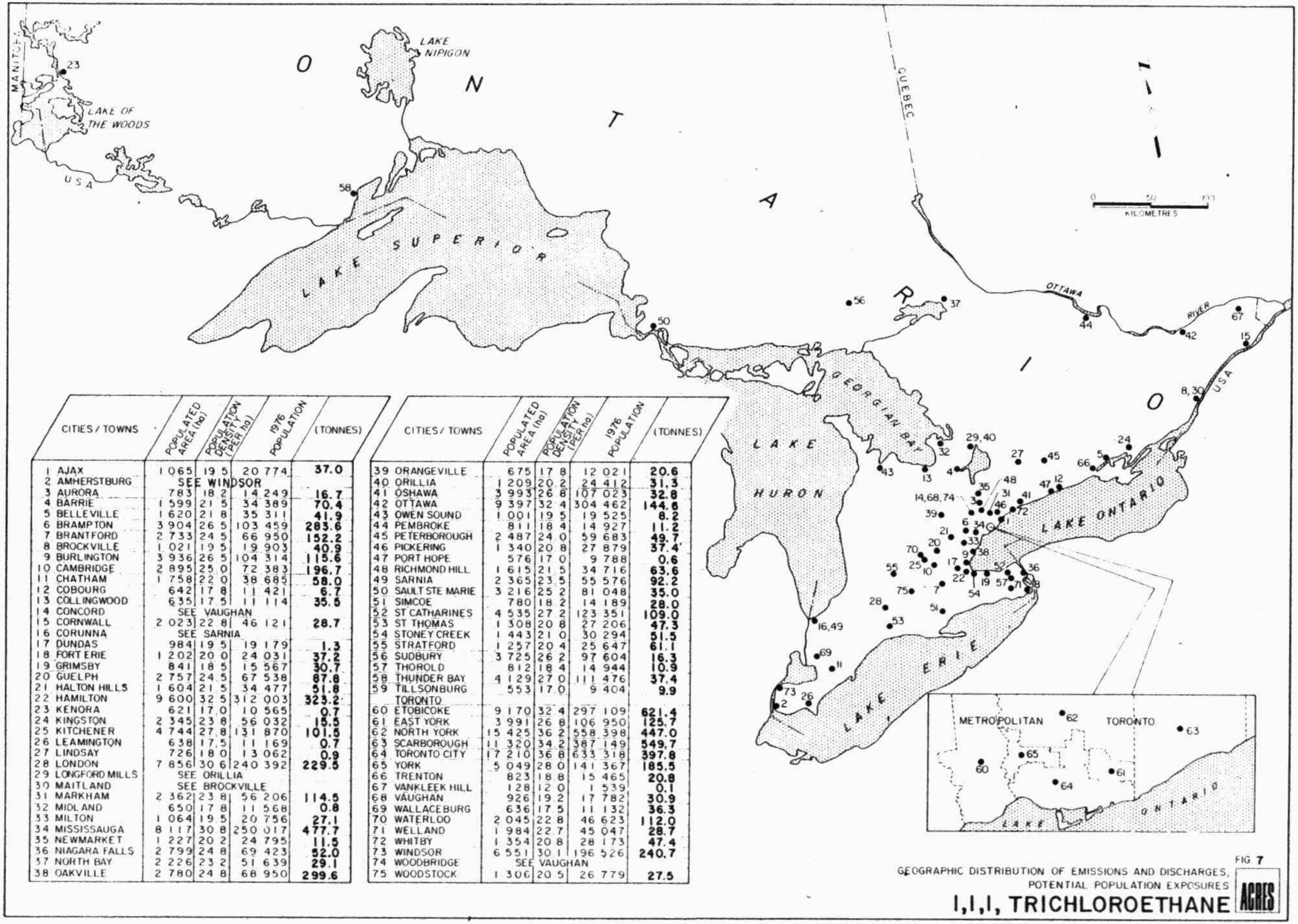
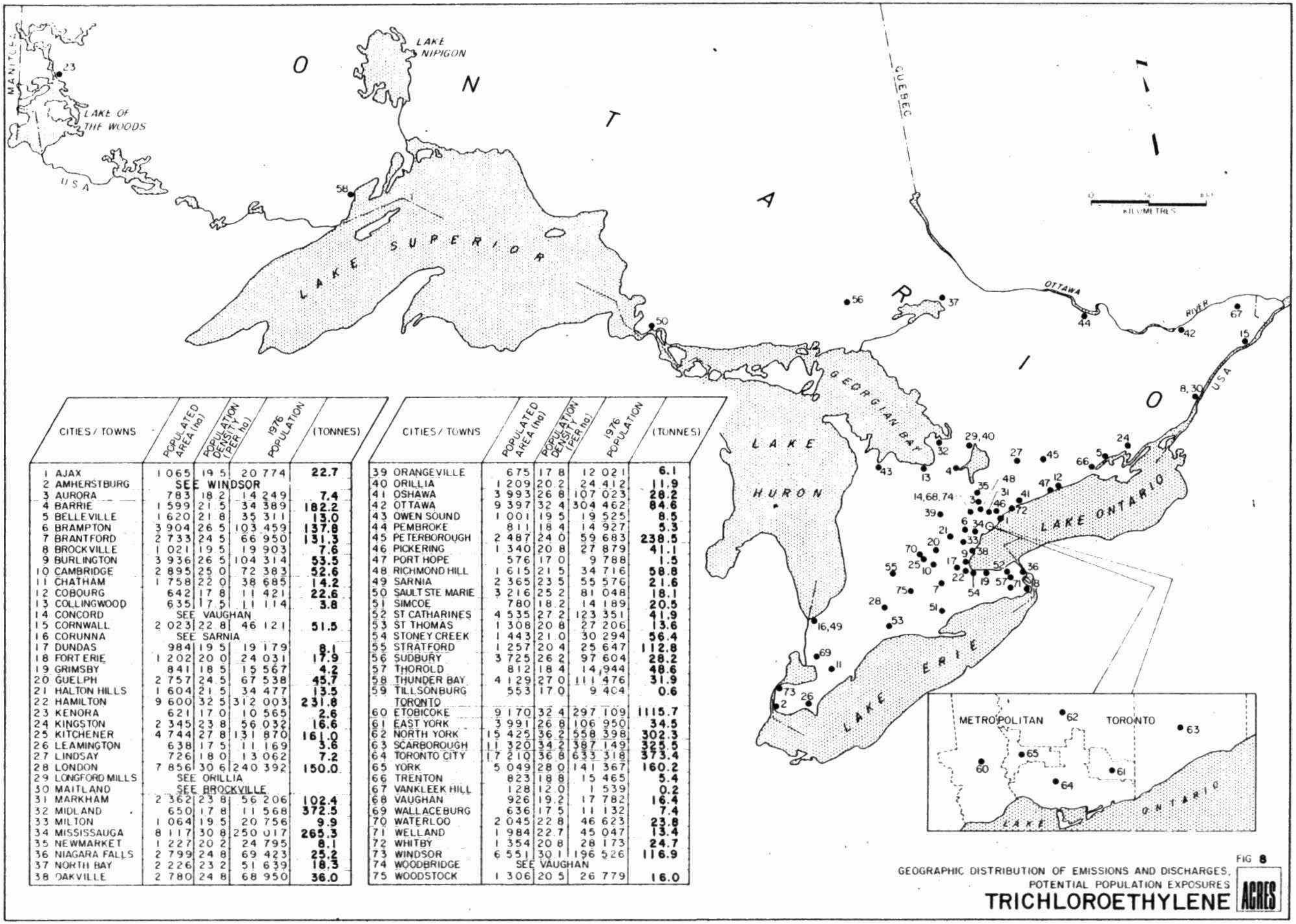


	CITIES / TOWNS	POPULATED AREA (ha)	POPULATION DENSITY (PER ha)	1976 POPULATION	(TONNES)
1	AJAX	1 065	19 5	20 774	**37.0**
2	AMHERSTBURG	SEE WINDSOR			
3	AURORA	783	18 2	14 249	**16.7**
4	BARRIE	1 599	21 5	34 389	**70.4**
5	BELLEVILLE	1 620	21 8	35 311	**41.9**
6	BRAMPTON	3 904	26 5	103 459	**283.6**
7	BRANTFORD	2 733	24 5	66 950	**152.2**
8	BROCKVILLE	1 021	19 5	19 903	**40.9**
9	BURLINGTON	3 936	26 5	104 314	**115.6**
10	CAMBRIDGE	2 895	25 0	72 383	**196.7**
11	CHATHAM	1 758	22 0	38 685	**58.0**
12	COBOURG	642	17 8	11 421	**6.7**
13	COLLINGWOOD	635	17 5	11 114	**35.5**
14	CONCORD	SEE VAUGHAN			
15	CORNWALL	2 023	22 8	46 121	**28.7**
16	CORUNNA	SEE SARNIA			
17	DUNDAS	984	19 5	19 179	**1.3**
18	FORT ERIE	1 202	20 0	24 031	**37.2**
19	GRIMSBY	841	18 5	15 567	**30.7**
20	GUELPH	2 757	24.5	67 538	**87.8**
21	HALTON HILLS	1 604	21 5	34 477	**51.8**
22	HAMILTON	9 600	32 5	312 003	**323.2**
23	KENORA	621	17.0	10 565	**0.7**
24	KINGSTON	2 345	23 8	56 032	**15.5**
25	KITCHENER	4 744	27 8	131 870	**101.5**
26	LEAMINGTON	638	17.5	11 169	**0.7**
27	LINDSAY	726	18 0	13 062	**0.9**
28	LONDON	7 856	30 6	240 392	**229.5**
29	LONGFORD MILLS	SEE ORILLIA			
30	MAITLAND	SEE BROCKVILLE			
31	MARKHAM	2 362	23 8	56 206	**114.5**
32	MIDLAND	650	17 8	11 568	**0.8**
33	MILTON	1 064	19 5	20 756	**27.1**
34	MISSISSAUGA	8 117	30 8	250 017	**477.7**
35	NEWMARKET	1 227	20 2	24 795	**11.5**
36	NIAGARA FALLS	2 799	24 8	69 423	**52.0**
37	NORTH BAY	2 226	23 2	51 639	**29.1**
38	OAKVILLE	2 780	24 8	68 950	**299.6**
39	ORANGEVILLE	675	17 8	12 021	**20.6**
40	ORILLIA	1 209	20.2	24 412	**31.3**
41	OSHAWA	3 993	26 8	107 023	**32.8**
42	OTTAWA	9 397	32 4	304 462	**144.6**
43	OWEN SOUND	1 001	19 5	19 525	**8.2**
44	PEMBROKE	811	18 4	14 927	**11.2**
45	PETERBOROUGH	2 487	24 0	59 683	**49.7**
46	PICKERING	1 340	20 8	27 879	**37.4**
47	PORT HOPE	576	17 0	9 788	**0.6**
48	RICHMOND HILL	1 615	21 5	34 716	**63.6**
49	SARNIA	2 365	23 5	55 576	**92.2**
50	SAULT STE MARIE	3 216	25 2	81 048	**35.0**
51	SIMCOE	780	18 2	14 189	**28.0**
52	ST CATHARINES	4 535	27 2	123 351	**109.0**
53	ST THOMAS	1 308	20 8	27 206	**47.3**
54	STONEY CREEK	1 443	21 0	30 294	**51.5**
55	STRATFORD	1 257	20 4	25 647	**61.1**
56	SUDBURY	3 725	26 2	97 604	**16.3**
57	THOROLD	812	18 4	14 944	**10.9**
58	THUNDER BAY	4 129	27 0	111 476	**37.4**
59	TILLSONBURG	553	17.0	9 404	**9.9**
	TORONTO				
60	ETOBICOKE	9 170	32 4	297 109	**621.4**
61	EAST YORK	3 991	26 8	106 950	**125.7**
62	NORTH YORK	15 425	36 2	558 398	**447.0**
63	SCARBOROUGH	11 320	34.2	387 149	**549.7**
64	TORONTO CITY	17 210	36 8	633 318	**397.8**
65	YORK	5 049	28 0	141 367	**185.5**
66	TRENTON	823	18.8	15 465	**20.8**
67	VANKLEEK HILL	128	12 0	1 539	**0.1**
68	VAUGHAN	926	19.2	17 782	**30.9**
69	WALLACEBURG	636	17.5	11 132	**36.3**
70	WATERLOO	2 045	22 8	46 623	**112.0**
71	WELLAND	1 984	22.7	45 047	**28.7**
72	WHITBY	1 354	20 8	28 173	**47.4**
73	WINDSOR	6 551	30 1	196 526	**240.7**
74	WOODBRIDGE	SEE VAUGHAN			
75	WOODSTOCK	1 306	20 5	26 779	**27.5**

FIG. 7

GEOGRAPHIC DISTRIBUTION OF EMISSIONS AND DISCHARGES,
POTENTIAL POPULATION EXPOSURES

1,1,1, TRICHLOROETHANE



CITIES / TOWNS	POPULATED AREA (ha)	POPULATION DENSITY (PER ha)	1976 POPULATION	(TONNES)
1 AJAX	1 065	19.5	20 774	**22.7**
2 AMHERSTBURG	SEE WINDSOR			
3 AURORA	783	18.2	14 249	**7.4**
4 BARRIE	1 599	21.5	34 389	**182.2**
5 BELLEVILLE	1 620	21.8	35 311	**13.0**
6 BRAMPTON	3 904	26.5	103 459	**137.8**
7 BRANTFORD	2 733	24.5	66 950	**131.3**
8 BROCKVILLE	1 021	19.5	19 903	**7.6**
9 BURLINGTON	3 936	26.5	104 314	**53.5**
10 CAMBRIDGE	2 895	25.0	72 383	**52.6**
11 CHATHAM	1 758	22.0	38 685	**14.2**
12 COBOURG	642	17.8	11 421	**22.6**
13 COLLINGWOOD	635	17.5	11 114	**3.8**
14 CONCORD	SEE VAUGHAN			
15 CORNWALL	2 023	22.8	46 121	**51.5**
16 CORUNNA	SEE SARNIA			
17 DUNDAS	984	19.5	19 179	**8.1**
18 FORT ERIE	1 202	20.0	24 031	**17.9**
19 GRIMSBY	841	18.5	15 567	**4.2**
20 GUELPH	2 757	24.5	67 538	**45.7**
21 HALTON HILLS	1 604	21.5	34 477	**13.5**
22 HAMILTON	9 600	32.5	312 003	**231.8**
23 KENORA	621	17.0	10 565	**2.6**
24 KINGSTON	2 345	23.8	56 032	**16.6**
25 KITCHENER	4 744	27.8	131 870	**161.0**
26 LEAMINGTON	638	17.5	11 169	**3.6**
27 LINDSAY	726	18.0	13 062	**7.2**
28 LONDON	7 856	30.6	240 392	**150.0**
29 LONGFORD MILLS	SEE ORILLIA			
30 MAITLAND	SEE BROCKVILLE			
31 MARKHAM	2 362	23.8	56 206	**102.4**
32 MIDLAND	650	17.8	11 568	**372.5**
33 MILTON	1 064	19.5	20 756	**9.9**
34 MISSISSAUGA	8 117	30.8	250 017	**265.3**
35 NEWMARKET	1 227	20.2	24 795	**8.1**
36 NIAGARA FALLS	2 799	24.8	69 423	**25.2**
37 NORTH BAY	2 226	23.2	51 639	**18.3**
38 OAKVILLE	2 780	24.8	68 950	**36.0**
39 ORANGEVILLE	675	17.8	12 021	**6.1**
40 ORILLIA	1 209	20.2	24 412	**11.9**
41 OSHAWA	3 993	26.8	107 023	**28.2**
42 OTTAWA	9 397	32.4	304 462	**84.6**
43 OWEN SOUND	1 001	19.5	19 525	**8.5**
44 PEMBROKE	811	18.4	14 927	**5.3**
45 PETERBOROUGH	2 487	24.0	59 683	**238.5**
46 PICKERING	1 340	20.8	27 879	**41.1**
47 PORT HOPE	576	17.0	9 788	**1.5**
48 RICHMOND HILL	1 615	21.5	34 716	**58.8**
49 SARNIA	2 365	23.5	55 576	**21.6**
50 SAULT STE MARIE	3 216	25.2	81 048	**18.1**
51 SIMCOE	780	18.2	14 189	**20.5**
52 ST CATHARINES	4 535	27.2	123 351	**41.9**
53 ST THOMAS	1 308	20.8	27 206	**13.6**
54 STONEY CREEK	1 443	21.0	30 294	**56.4**
55 STRATFORD	1 257	20.4	25 647	**112.8**
56 SUDBURY	3 725	26.2	97 604	**28.2**
57 THOROLD	812	18.4	14,944	**48.6**
58 THUNDER BAY	4 129	27.0	111 476	**31.9**
59 TILLSONBURG	553	17.0	9 404	**0.6**
TORONTO				
60 ETOBICOKE	9 170	32.4	297 109	**1115.7**
61 EAST YORK	3 991	26.8	106 950	**34.5**
62 NORTH YORK	15 425	36.2	558 398	**302.3**
63 SCARBOROUGH	11 320	34.2	387 149	**325.5**
64 TORONTO CITY	17 210	36.8	633 318	**373.4**
65 YORK	5 049	28.0	141 367	**160.2**
66 TRENTON	823	18.8	15 465	**5.4**
67 VANKLEEK HILL	128	12.0	1 539	**0.2**
68 VAUGHAN	926	19.2	17 782	**16.4**
69 WALLACEBURG	636	17.5	11 132	**7.4**
70 WATERLOO	2 045	22.8	46 623	**23.8**
71 WELLAND	1 984	22.7	45 047	**13.4**
72 WHITBY	1 354	20.8	28 173	**24.7**
73 WINDSOR	6 551	30.1	196 526	**116.9**
74 WOODBRIDGE	SEE VAUGHAN			
75 WOODSTOCK	1 306	20.5	26 779	**16.0**

FIG **8**

GEOGRAPHIC DISTRIBUTION OF EMISSIONS AND DISCHARGES,
POTENTIAL POPULATION EXPOSURES

TRICHLOROETHYLENE

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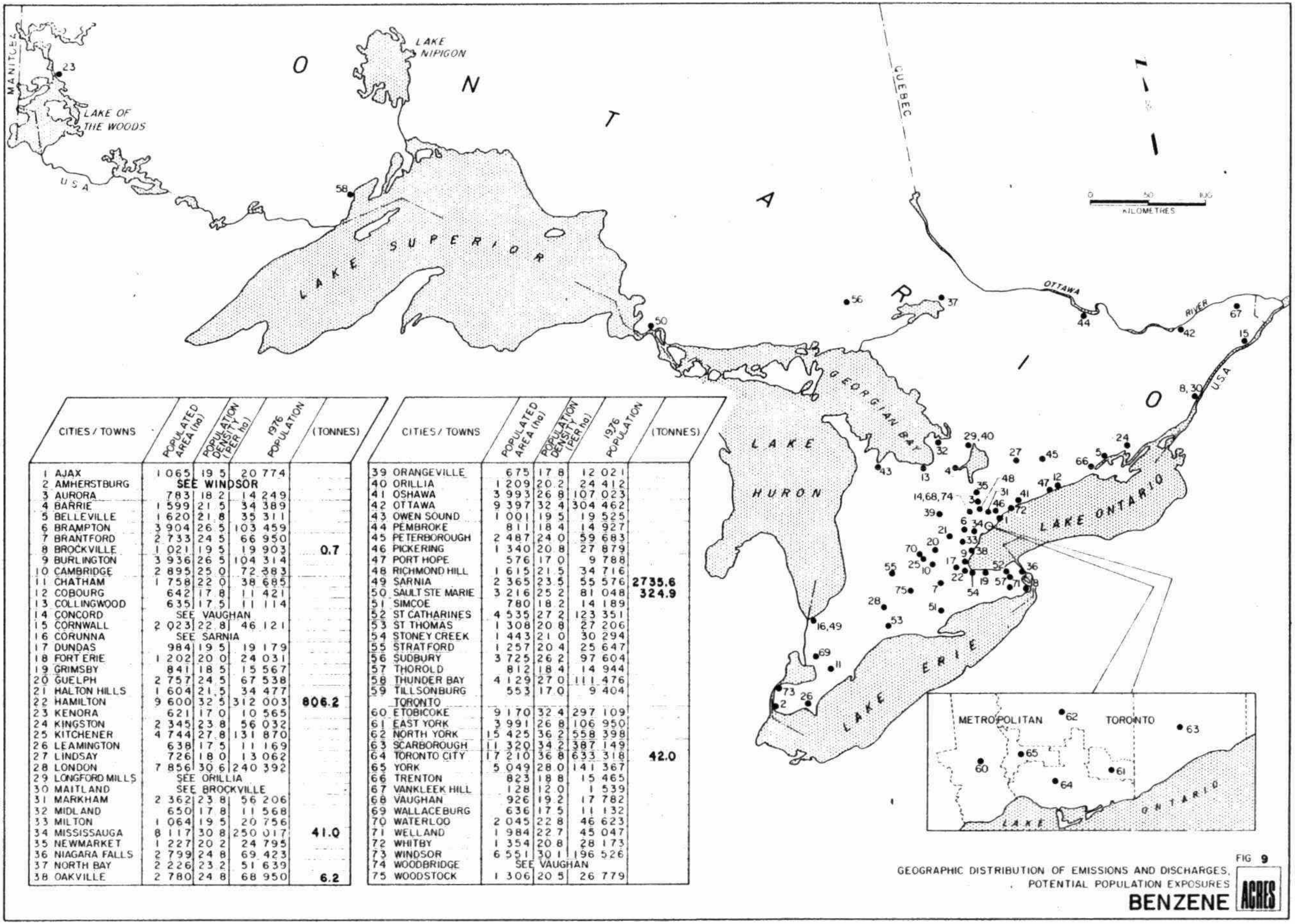


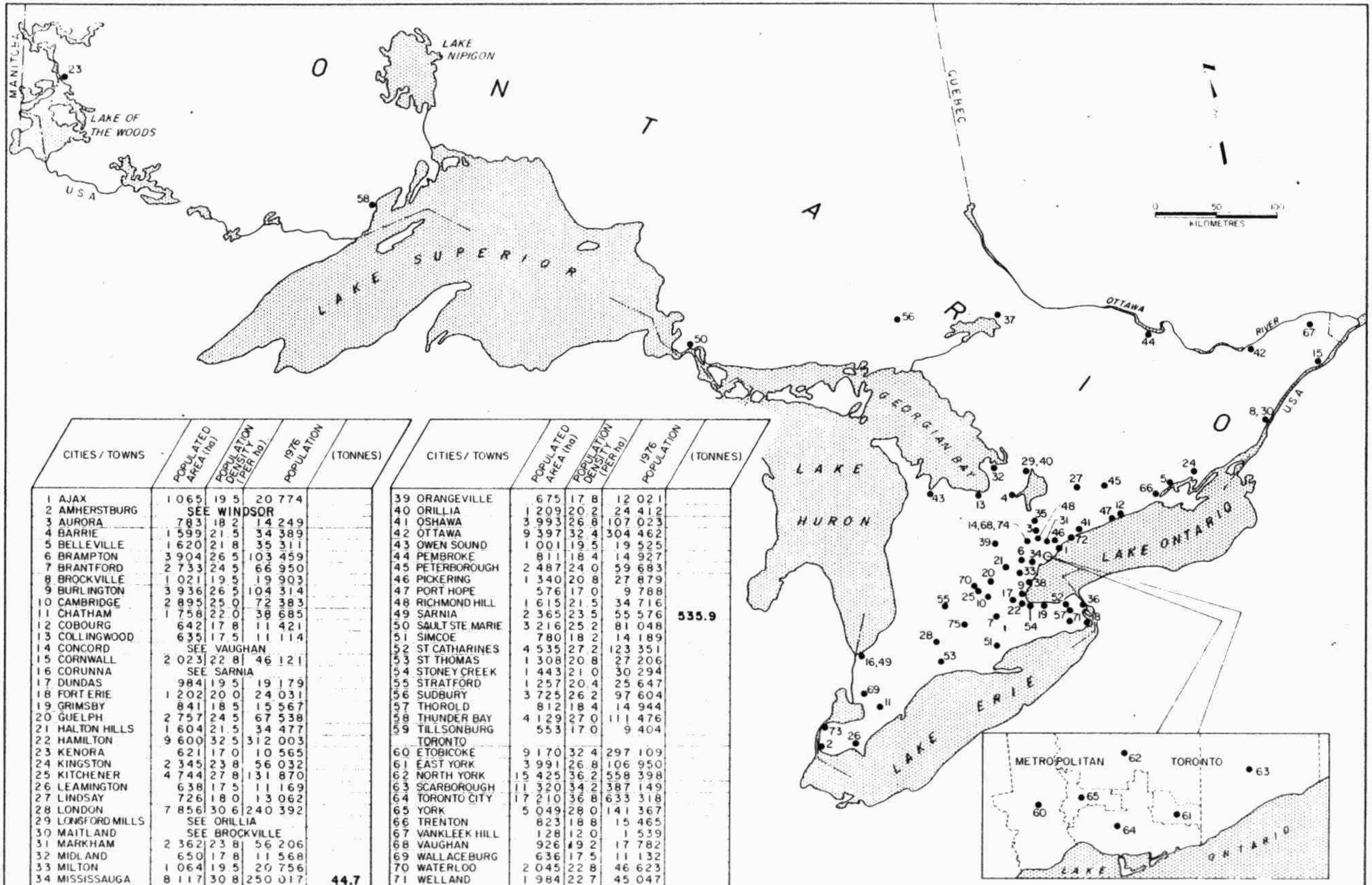
CITIES / TOWNS	POPULATED AREA (ha)	POPULATION DENSITY (PER ha)	1976 POPULATION	(TONNES)
1 AJAX	1 065	19.5	20 774	
2 AMHERSTBURG	SEE WINDSOR			
3 AURORA	783	18.2	14 249	
4 BARRIE	1 599	21.5	34 389	
5 BELLEVILLE	1 620	21.8	35 311	
6 BRAMPTON	3 904	26.5	103 459	
7 BRANTFORD	2 733	24.5	66 950	
8 BROCKVILLE	1 021	19.5	19 903	0.7
9 BURLINGTON	3 936	26.5	104 314	
10 CAMBRIDGE	2 895	25.0	72 383	
11 CHATHAM	1 758	22.0	38 685	
12 COBOURG	642	17.8	11 421	
13 COLLINGWOOD	635	17.5	11 114	
14 CONCORD	SEE VAUGHAN			
15 CORNWALL	2 023	22.8	46 121	
16 CORUNNA	SEE SARNIA			
17 DUNDAS	984	19.5	19 179	
18 FORT ERIE	1 202	20.0	24 031	
19 GRIMSBY	841	18.5	15 567	
20 GUELPH	2 757	24.5	67 538	
21 HALTON HILLS	1 604	21.5	34 477	
22 HAMILTON	9 600	32.5	312 003	806.2
23 KENORA	621	17.0	10 565	
24 KINGSTON	2 345	23.8	56 032	
25 KITCHENER	4 744	27.8	131 870	
26 LEAMINGTON	638	17.5	11 169	
27 LINDSAY	726	18.0	13 062	
28 LONDON	7 856	30.6	240 392	
29 LONGFORD MILLS	SEE ORILLIA			
30 MAITLAND	SEE BROCKVILLE			
31 MARKHAM	2 362	23.8	56 206	
32 MIDLAND	650	17.8	11 568	
33 MILTON	1 064	19.5	20 756	
34 MISSISSAUGA	8 117	30.8	250 017	41.0
35 NEWMARKET	1 227	20.2	24 795	
36 NIAGARA FALLS	2 799	24.8	69 423	
37 NORTH BAY	2 226	23.2	51 639	
38 OAKVILLE	2 780	24.8	68 950	6.2

CITIES / TOWNS	POPULATED AREA (ha)	POPULATION DENSITY (PER ha)	1976 POPULATION	(TONNES)
39 ORANGEVILLE	675	17.8	12 021	
40 ORILLIA	1 209	20.2	24 412	
41 OSHAWA	3 993	26.8	107 023	
42 OTTAWA	9 397	32.4	304 462	
43 OWEN SOUND	1 001	19.5	19 525	
44 PEMBROKE	811	18.4	14 927	
45 PETERBOROUGH	2 487	24.0	59 683	
46 PICKERING	1 340	20.8	27 879	
47 PORT HOPE	576	17.0	9 788	
48 RICHMOND HILL	1 615	21.5	34 716	
49 SARNIA	2 365	23.5	55 576	2735.6
50 SAULT STE MARIE	3 216	25.2	81 048	324.9
51 SIMCOE	780	18.2	14 189	
52 ST CATHARINES	4 535	27.2	123 351	
53 ST THOMAS	1 308	20.8	27 206	
54 STONEY CREEK	1 443	21.0	30 294	
55 STRATFORD	1 257	20.4	25 647	
56 SUDBURY	3 725	26.2	97 604	
57 THOROLD	812	18.4	14 944	
58 THUNDER BAY	4 129	27.0	111 476	
59 TILLSONBURG	553	17.0	9 404	
TORONTO				
60 ETOBICOKE	9 170	32.4	297 109	
61 EAST YORK	3 991	26.8	106 950	
62 NORTH YORK	15 425	36.2	558 398	
63 SCARBOROUGH	11 320	34.2	387 149	
64 TORONTO CITY	17 210	36.8	633 318	42.0
65 YORK	5 049	28.0	141 367	
66 TRENTON	823	18.8	15 465	
67 VANKLEEK HILL	128	12.0	1 539	
68 VAUGHAN	926	19.2	17 782	
69 WALLACEBURG	636	17.5	11 132	
70 WATERLOO	2 045	22.8	46 623	
71 WELLAND	1 984	22.7	45 047	
72 WHITBY	1 354	20.8	28 173	
73 WINDSOR	6 551	30.1	196 526	
74 WOODBRIDGE	SEE VAUGHAN			
75 WOODSTOCK	1 306	20.5	26 779	

FIG 9

GEOGRAPHIC DISTRIBUTION OF EMISSIONS AND DISCHARGES,
POTENTIAL POPULATION EXPOSURES

BENZENE



CITIES / TOWNS	POPULATED AREA (ha)	POPULATION DENSITY (PER ha)	1976 POPULATION	(TONNES)
1 AJAX	1 065	19.5	20 774	
2 AMHERSTBURG	SEE WINDSOR			
3 AURORA	783	18.2	14 249	
4 BARRIE	1 599	21.5	34 389	
5 BELLEVILLE	1 620	21.8	35 311	
6 BRAMPTON	3 904	26.5	103 459	
7 BRANTFORD	2 733	24.5	66 950	
8 BROCKVILLE	1 021	19.5	19 903	
9 BURLINGTON	3 936	26.5	104 314	
10 CAMBRIDGE	2 895	25.0	72 383	
11 CHATHAM	1 758	22.0	38 685	
12 COBOURG	642	17.8	11 421	
13 COLLINGWOOD	635	17.5	11 114	
14 CONCORD	SEE VAUGHAN			
15 CORNWALL	2 023	22.8	46 121	
16 CORUNNA	SEE SARNIA			
17 DUNDAS	984	19.5	19 179	
18 FORT ERIE	1 202	20.0	24 031	
19 GRIMSBY	841	18.5	15 567	
20 GUELPH	2 757	24.5	67 538	
21 HALTON HILLS	1 604	21.5	34 477	
22 HAMILTON	9 600	32.5	312 003	
23 KENORA	621	17.0	10 565	
24 KINGSTON	2 345	23.8	56 032	
25 KITCHENER	4 744	27.8	131 870	
26 LEAMINGTON	638	17.5	11 169	
27 LINDSAY	726	18.0	13 062	
28 LONDON	7 856	30.6	240 392	
29 LONGFORD MILLS	SEE ORILLIA			
30 MAITLAND	SEE BROCKVILLE			
31 MARKHAM	2 362	23.8	56 206	
32 MIDLAND	650	17.8	11 568	
33 MILTON	1 064	19.5	20 756	
34 MISSISSAUGA	8 117	30.8	250 017	44.7
35 NEWMARKET	1 227	20.2	24 795	
36 NIAGARA FALLS	2 799	24.8	69 423	
37 NORTH BAY	2 226	23.2	51 639	
38 OAKVILLE	2 780	24.8	68 950	11.0
39 ORANGEVILLE	675	17.8	12 021	
40 ORILLIA	1 209	20.2	24 412	
41 OSHAWA	3 993	26.8	107 023	
42 OTTAWA	9 397	32.4	304 462	
43 OWEN SOUND	1 001	19.5	19 525	
44 PEMBROKE	811	18.4	14 927	
45 PETERBOROUGH	2 487	24.0	59 683	
46 PICKERING	1 340	20.8	27 879	
47 PORT HOPE	576	17.0	9 788	
48 RICHMOND HILL	1 615	21.5	34 716	
49 SARNIA	2 365	23.5	55 576	535.9
50 SAULT STE MARIE	3 216	25.2	81 048	
51 SIMCOE	780	18.2	14 189	
52 ST CATHARINES	4 535	27.2	123 351	
53 ST THOMAS	1 308	20.8	27 206	
54 STONEY CREEK	1 443	21.0	30 294	
55 STRATFORD	1 257	20.4	25 647	
56 SUDBURY	3 725	26.2	97 604	
57 THOROLD	812	18.4	14 944	
58 THUNDER BAY	4 129	27.0	111 476	
59 TILLSONBURG	553	17.0	9 404	
TORONTO				
60 ETOBICOKE	9 170	32.4	297 109	
61 EAST YORK	3 991	26.8	106 950	
62 NORTH YORK	15 425	36.2	558 398	
63 SCARBOROUGH	11 320	34.2	387 149	
64 TORONTO CITY	17 210	36.8	633 318	
65 YORK	5 049	28.0	141 367	
66 TRENTON	823	18.8	15 465	
67 VANKLEEK HILL	128	12.0	1 539	
68 VAUGHAN	926	19.2	17 782	
69 WALLACEBURG	636	17.5	11 132	
70 WATERLOO	2 045	22.8	46 623	
71 WELLAND	1 984	22.7	45 047	
72 WHITBY	1 354	20.8	28 173	
73 WINDSOR	6 551	30.1	196 526	
74 WOODBRIDGE	SEE VAUGHAN			
75 WOODSTOCK	1 306	20.5	26 779	

FIG. 10

GEOGRAPHIC DISTRIBUTION OF EMISSIONS AND DISCHARGES, POTENTIAL POPULATION EXPOSURES

ETHYLBENZENE

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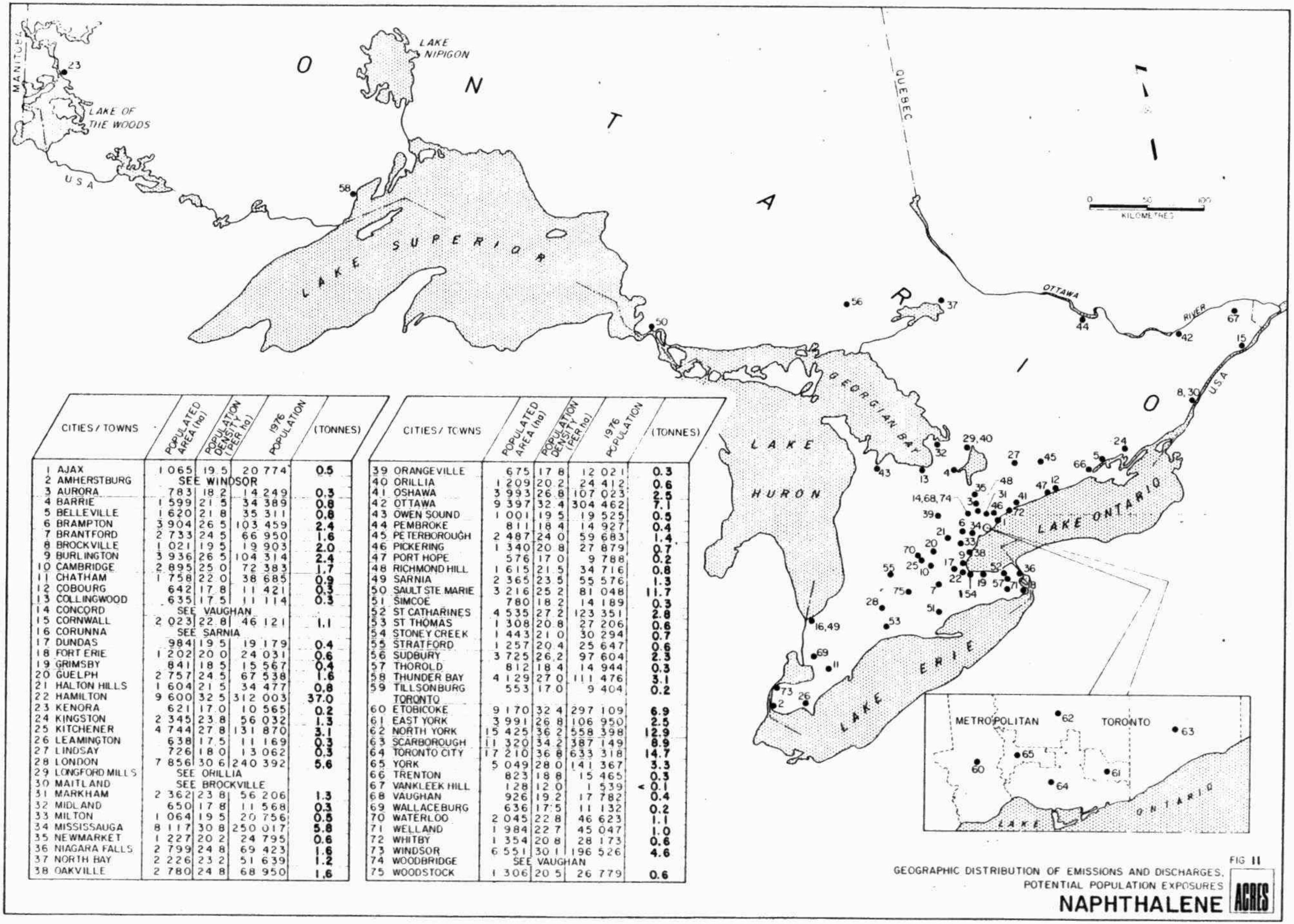
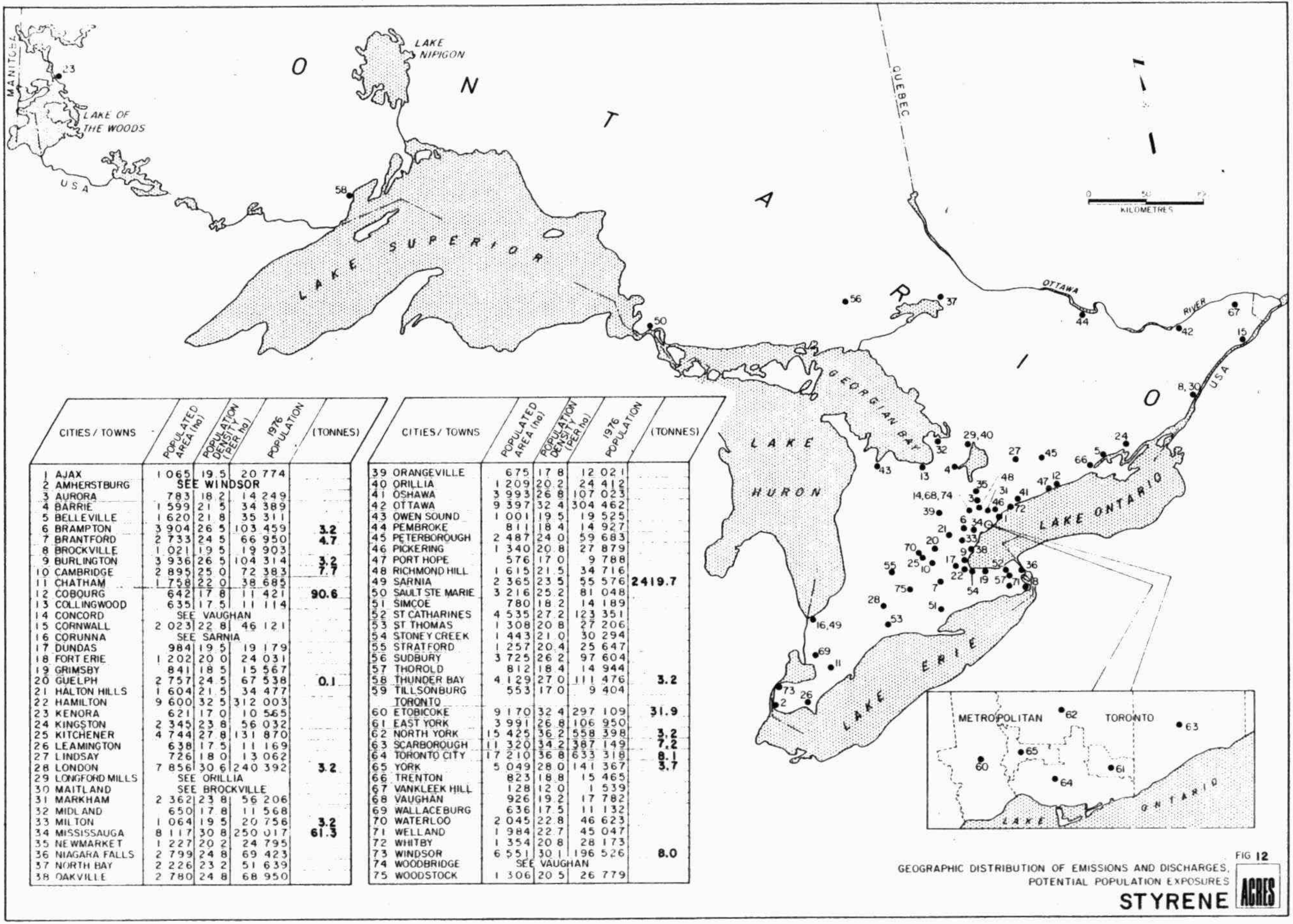


CITIES / TOWNS	POPULATED AREA (ha)	POPULATION DENSITY (PER ha)	1976 POPULATION	(TONNES)
1 AJAX	1 065	19.5	20 774	0.5
2 AMHERSTBURG	SEE WINDSOR			
3 AURORA	783	18.2	14 249	0.3
4 BARRIE	1 599	21.5	34 389	0.8
5 BELLEVILLE	1 620	21.8	35 311	0.8
6 BRAMPTON	3 904	26.5	103 459	2.4
7 BRANTFORD	2 733	24.5	66 950	1.6
8 BROCKVILLE	1 021	19.5	19 903	2.0
9 BURLINGTON	3 936	26.5	104 314	2.4
10 CAMBRIDGE	2 895	25.0	72 383	1.7
11 CHATHAM	1 758	22.0	38 685	0.9
12 COBOURG	642	17.8	11 421	0.3
13 COLLINGWOOD	635	17.5	11 114	0.3
14 CONCORD	SEE VAUGHAN			
15 CORNWALL	2 023	22.8	46 121	1.1
16 CORUNNA	SEE SARNIA			
17 DUNDAS	984	19.5	19 179	0.4
18 FORT ERIE	1 202	20.0	24 031	0.6
19 GRIMSBY	841	18.5	15 567	0.4
20 GUELPH	2 757	24.5	67 538	1.6
21 HALTON HILLS	1 604	21.5	34 477	0.8
22 HAMILTON	9 600	32.5	312 003	37.0
23 KENORA	621	17.0	10 565	0.2
24 KINGSTON	2 345	23.8	56 032	1.3
25 KITCHENER	4 744	27.8	131 870	3.1
26 LEAMINGTON	638	17.5	11 169	0.3
27 LINDSAY	726	18.0	13 062	0.3
28 LONDON	7 856	30.6	240 392	5.6
29 LONGFORD MILLS	SEE ORILLIA			
30 MAITLAND	SEE BROCKVILLE			
31 MARKHAM	2 362	23.8	56 206	1.3
32 MIDLAND	650	17.8	11 568	0.3
33 MILTON	1 064	19.5	20 756	0.5
34 MISSISSAUGA	8 117	30.8	250 017	5.8
35 NEWMARKET	1 227	20.2	24 795	0.6
36 NIAGARA FALLS	2 799	24.8	69 423	1.6
37 NORTH BAY	2 226	23.2	51 639	1.2
38 OAKVILLE	2 780	24.8	68 950	1.6
39 ORANGEVILLE	675	17.8	12 021	0.3
40 ORILLIA	1 209	20.2	24 412	0.6
41 OSHAWA	3 993	26.8	107 023	2.5
42 OTTAWA	9 397	32.4	304 462	7.1
43 OWEN SOUND	1 001	19.5	19 525	0.5
44 PEMBROKE	811	18.4	14 927	0.4
45 PETERBOROUGH	2 487	24.0	59 683	1.4
46 PICKERING	1 340	20.8	27 879	0.7
47 PORT HOPE	576	17.0	9 788	0.2
48 RICHMOND HILL	1 615	21.5	34 716	0.8
49 SARNIA	2 365	23.5	55 576	1.3
50 SAULT STE MARIE	3 216	25.2	81 048	11.7
51 SIMCOE	780	18.2	14 189	0.3
52 ST CATHARINES	4 535	27.2	123 351	2.8
53 ST THOMAS	1 308	20.8	27 206	0.6
54 STONEY CREEK	1 443	21.0	30 294	0.7
55 STRATFORD	1 257	20.4	25 647	0.6
56 SUDBURY	3 725	26.2	97 604	2.3
57 THOROLD	812	18.4	14 944	0.3
58 THUNDER BAY	4 129	27.0	111 476	3.1
59 TILLSONBURG	553	17.0	9 404	0.2
TORONTO				
60 ETOBICOKE	9 170	32.4	297 109	6.9
61 EAST YORK	3 991	26.8	106 950	2.5
62 NORTH YORK	15 425	36.2	558 398	12.9
63 SCARBOROUGH	11 320	34.2	387 149	8.9
64 TORONTO CITY	17 210	36.8	633 318	14.7
65 YORK	5 049	28.0	141 367	3.3
66 TRENTON	823	18.8	15 465	0.3
67 VANKLEEK HILL	128	12.0	1 539	< 0.1
68 VAUGHAN	926	19.2	17 782	0.4
69 WALLACEBURG	636	17.5	11 132	0.2
70 WATERLOO	2 045	22.8	46 623	1.1
71 WELLAND	1 984	22.7	45 047	1.0
72 WHITBY	1 354	20.8	28 173	0.6
73 WINDSOR	6 551	30.1	196 526	4.6
74 WOODBRIDGE	SEE VAUGHAN			
75 WOODSTOCK	1 306	20.5	26 779	0.6

FIG 11

GEOGRAPHIC DISTRIBUTION OF EMISSIONS AND DISCHARGES,
POTENTIAL POPULATION EXPOSURES

NAPHTHALENE



	CITIES / TOWNS	POPULATED AREA (ha)	POPULATION DENSITY (PER ha)	1976 POPULATION	(TONNES)
1	AJAX	1 065	19.5	20 774	
2	AMHERSTBURG	SEE WINDSOR			
3	AURORA	783	18.2	14 249	
4	BARRIE	1 599	21.5	34 389	
5	BELLEVILLE	1 620	21.8	35 311	
6	BRAMPTON	3 904	26.5	103 459	3.2
7	BRANTFORD	2 733	24.5	66 950	4.7
8	BROCKVILLE	1 021	19.5	19 903	
9	BURLINGTON	3 936	26.5	104 314	3.2
10	CAMBRIDGE	2 895	25.0	72 383	7.7
11	CHATHAM	1 758	22.0	38 685	
12	COBOURG	642	17.8	11 421	90.6
13	COLLINGWOOD	635	17.5	11 114	
14	CONCORD	SEE VAUGHAN			
15	CORNWALL	2 023	22.8	46 121	
16	CORUNNA	SEE SARNIA			
17	DUNDAS	984	19.5	19 179	
18	FORT ERIE	1 202	20.0	24 031	
19	GRIMSBY	841	18.5	15 567	
20	GUELPH	2 757	24.5	67 538	0.1
21	HALTON HILLS	1 604	21.5	34 477	
22	HAMILTON	9 600	32.5	312 003	
23	KENORA	621	17.0	10 565	
24	KINGSTON	2 345	23.8	56 032	
25	KITCHENER	4 744	27.8	131 870	
26	LEAMINGTON	638	17.5	11 169	
27	LINDSAY	726	18.0	13 062	
28	LONDON	7 856	30.6	240 392	3.2
29	LONGFORD MILLS	SEE ORILLIA			
30	MAITLAND	SEE BROCKVILLE			
31	MARKHAM	2 362	23.8	56 206	
32	MIDLAND	650	17.8	11 568	
33	MILTON	1 064	19.5	20 756	3.2
34	MISSISSAUGA	8 117	30.8	250 017	61.3
35	NEWMARKET	1 227	20.2	24 795	
36	NIAGARA FALLS	2 799	24.8	69 423	
37	NORTH BAY	2 226	23.2	51 639	
38	OAKVILLE	2 780	24.8	68 950	

	CITIES / TOWNS	POPULATED AREA (ha)	POPULATION DENSITY (PER ha)	1976 POPULATION	(TONNES)
39	ORANGEVILLE	675	17.8	12 021	
40	ORILLIA	1 209	20.2	24 412	
41	OSHAWA	3 993	26.8	107 023	
42	OTTAWA	9 397	32.4	304 462	
43	OWEN SOUND	1 001	19.5	19 525	
44	PEMBROKE	811	18.4	14 927	
45	PETERBOROUGH	2 487	24.0	59 683	
46	PICKERING	1 340	20.8	27 879	
47	PORT HOPE	576	17.0	9 788	
48	RICHMOND HILL	1 615	21.5	34 716	
49	SARNIA	2 365	23.5	55 576	2419.7
50	SAULT STE MARIE	3 216	25.2	81 048	
51	SIMCOE	780	18.2	14 189	
52	ST CATHARINES	4 535	27.2	123 351	
53	ST THOMAS	1 308	20.8	27 206	
54	STONEY CREEK	1 443	21.0	30 294	
55	STRATFORD	1 257	20.4	25 647	
56	SUDBURY	3 725	26.2	97 604	
57	THOROLD	812	18.4	14 944	
58	THUNDER BAY	4 129	27.0	111 476	3.2
59	TILLSONBURG	553	17.0	9 404	
	TORONTO				
60	ETOBICOKE	9 170	32.4	297 109	31.9
61	EAST YORK	3 991	26.8	106 950	
62	NORTH YORK	15 425	36.2	558 398	3.2
63	SCARBOROUGH	11 320	34.2	387 149	7.2
64	TORONTO CITY	17 210	36.8	633 318	8.1
65	YORK	5 049	28.0	141 367	3.7
66	TRENTON	823	18.8	15 465	
67	VANKLEEK HILL	128	12.0	1 539	
68	VAUGHAN	926	19.2	17 782	
69	WALLACEBURG	636	17.5	11 132	
70	WATERLOO	2 045	22.8	46 623	
71	WELLAND	1 984	22.7	45 047	
72	WHITBY	1 354	20.8	28 173	
73	WINDSOR	6 551	30.1	196 526	8.0
74	WOODBRIDGE	SEE VAUGHAN			
75	WOODSTOCK	1 306	20.5	26 779	

FIG 12

GEOGRAPHIC DISTRIBUTION OF EMISSIONS AND DISCHARGES,
POTENTIAL POPULATION EXPOSURES

STYRENE

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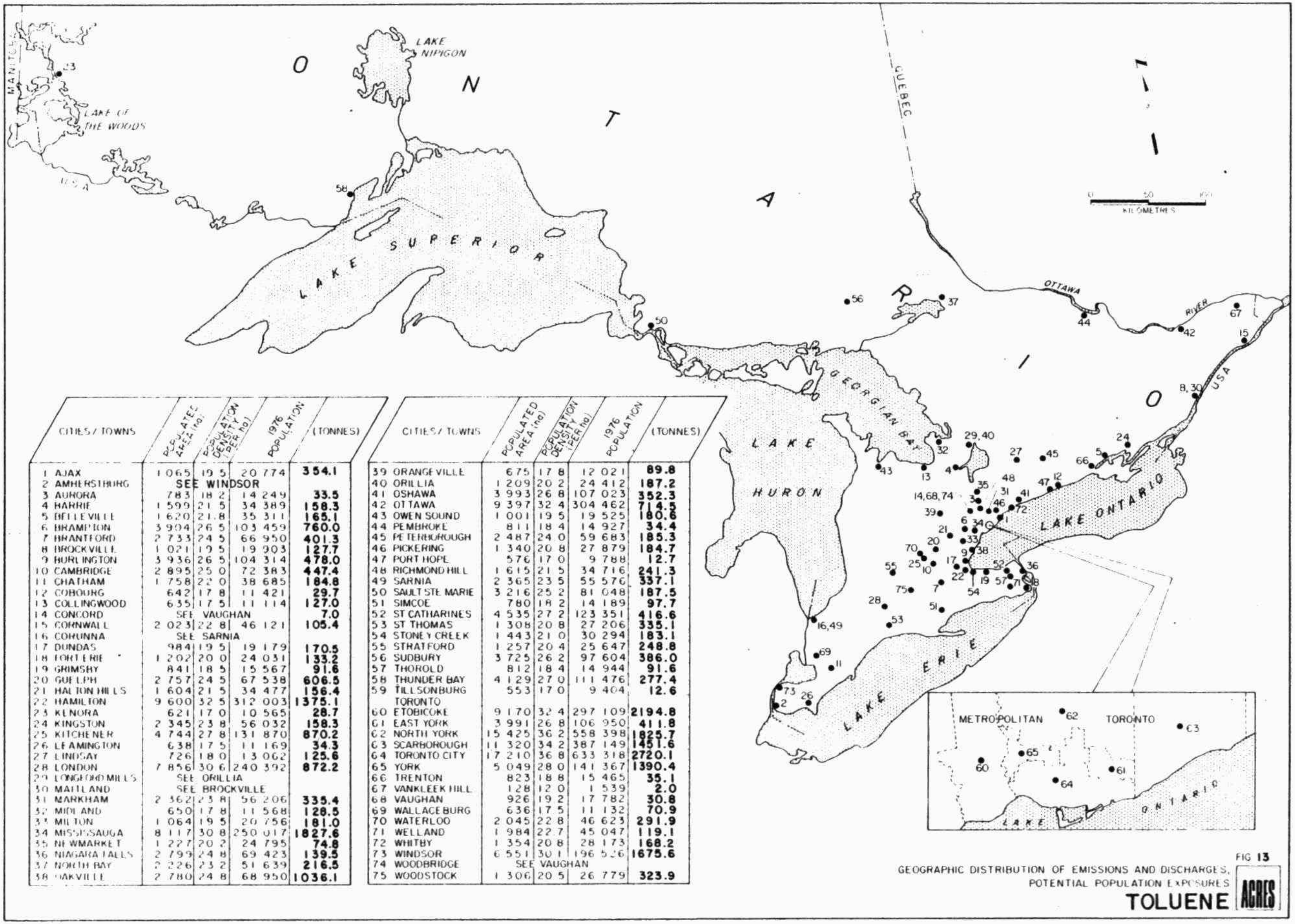


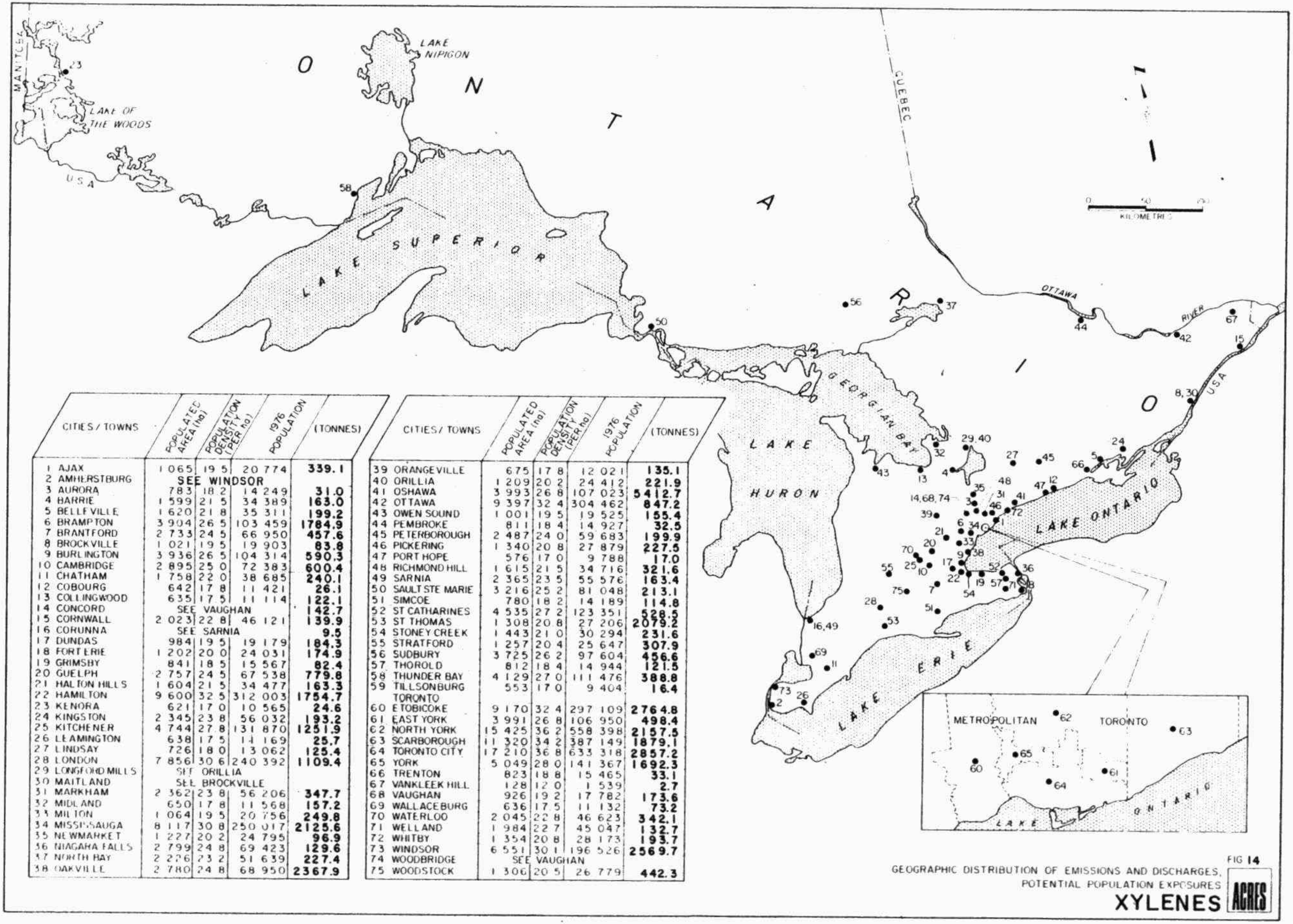
CITIES / TOWNS	POPULATED AREA (ha)	POPULATION DENSITY (PER ha)	1976 POPULATION	(TONNES)
1 AJAX	1 065	19.5	20 774	**354.1**
2 AMHERSTBURG	SEE WINDSOR			
3 AURORA	783	18.2	14 249	**33.5**
4 BARRIE	1 599	21.5	34 389	**158.3**
5 BELLEVILLE	1 620	21.8	35 311	**165.1**
6 BRAMPTON	3 904	26.5	103 459	**760.0**
7 BRANTFORD	2 733	24.5	66 950	**401.3**
8 BROCKVILLE	1 021	19.5	19 903	**127.7**
9 BURLINGTON	3 936	26.5	104 314	**478.0**
10 CAMBRIDGE	2 895	25.0	72 383	**447.4**
11 CHATHAM	1 758	22.0	38 685	**184.8**
12 COBOURG	642	17.8	11 421	**29.7**
13 COLLINGWOOD	635	17.5	11 114	**127.0**
14 CONCORD	SEE VAUGHAN			**7.0**
15 CORNWALL	2 023	22.8	46 121	**105.4**
16 CORUNNA	SEE SARNIA			
17 DUNDAS	984	19.5	19 179	**170.5**
18 FORT ERIE	1 202	20.0	24 031	**133.2**
19 GRIMSBY	841	18.5	15 567	**91.6**
20 GUELPH	2 757	24.5	67 538	**606.5**
21 HALTON HILLS	1 604	21.5	34 477	**156.4**
22 HAMILTON	9 600	32.5	312 003	**1375.1**
23 KENORA	621	17.0	10 565	**28.7**
24 KINGSTON	2 345	23.8	56 032	**158.3**
25 KITCHENER	4 744	27.8	131 870	**870.2**
26 LEAMINGTON	638	17.5	11 169	**34.3**
27 LINDSAY	726	18.0	13 062	**125.6**
28 LONDON	7 856	30.6	240 392	**872.2**
29 LONGFORD MILLS	SEE ORILLIA			
30 MAITLAND	SEE BROCKVILLE			
31 MARKHAM	2 362	23.8	56 206	**335.4**
32 MIDLAND	650	17.8	11 568	**128.5**
33 MILTON	1 064	19.5	20 756	**181.0**
34 MISSISSAUGA	8 117	30.8	250 017	**1827.6**
35 NEWMARKET	1 227	20.2	24 795	**74.8**
36 NIAGARA FALLS	2 799	24.8	69 423	**139.5**
37 NORTH BAY	2 226	23.2	51 639	**216.5**
38 OAKVILLE	2 780	24.8	68 950	**1036.1**
39 ORANGEVILLE	675	17.8	12 021	**89.8**
40 ORILLIA	1 209	20.2	24 412	**187.2**
41 OSHAWA	3 993	26.8	107 023	**352.3**
42 OTTAWA	9 397	32.4	304 462	**714.5**
43 OWEN SOUND	1 001	19.5	19 525	**180.6**
44 PEMBROKE	811	18.4	14 927	**34.4**
45 PETERBOROUGH	2 487	24.0	59 683	**185.3**
46 PICKERING	1 340	20.8	27 879	**184.7**
47 PORT HOPE	576	17.0	9 788	**12.7**
48 RICHMOND HILL	1 615	21.5	34 716	**241.3**
49 SARNIA	2 365	23.5	55 576	**337.1**
50 SAULT STE MARIE	3 216	25.2	81 048	**187.5**
51 SIMCOE	780	18.2	14 189	**97.7**
52 ST CATHARINES	4 535	27.2	123 351	**416.6**
53 ST THOMAS	1 308	20.8	27 206	**335.1**
54 STONEY CREEK	1 443	21.0	30 294	**183.1**
55 STRATFORD	1 257	20.4	25 647	**248.8**
56 SUDBURY	3 725	26.2	97 604	**386.0**
57 THOROLD	812	18.4	14 944	**91.6**
58 THUNDER BAY	4 129	27.0	111 476	**277.4**
59 TILLSONBURG	553	17.0	9 404	**12.6**
TORONTO				
60 ETOBICOKE	9 170	32.4	297 109	**2194.8**
61 EAST YORK	3 991	26.8	106 950	**411.8**
62 NORTH YORK	15 425	36.2	558 398	**1825.7**
63 SCARBOROUGH	11 320	34.2	387 149	**1451.6**
64 TORONTO CITY	17 210	36.8	633 318	**2720.1**
65 YORK	5 049	28.0	141 367	**1390.4**
66 TRENTON	823	18.8	15 465	**35.1**
67 VANKLEEK HILL	128	12.0	1 539	**2.0**
68 VAUGHAN	926	19.2	17 782	**30.8**
69 WALLACEBURG	636	17.5	11 132	**70.9**
70 WATERLOO	2 045	22.8	46 623	**291.9**
71 WELLAND	1 984	22.7	45 047	**119.1**
72 WHITBY	1 354	20.8	28 173	**168.2**
73 WINDSOR	6 551	30.1	196 526	**1675.6**
74 WOODBRIDGE	SEE VAUGHAN			
75 WOODSTOCK	1 306	20.5	26 779	**323.9**

FIG 13

GEOGRAPHIC DISTRIBUTION OF EMISSIONS AND DISCHARGES,
POTENTIAL POPULATION EXPOSURES

TOLUENE

ACRES



CITIES / TOWNS	POPULATED AREA (ha)	POPULATION DENSITY (PER ha)	1976 POPULATION	(TONNES)
1 AJAX	1 065	19.5	20 774	**339.1**
2 AMHERSTBURG	SEE WINDSOR			
3 AURORA	783	18.2	14 249	**31.0**
4 BARRIE	1 599	21.5	34 389	**163.0**
5 BELLEVILLE	1 620	21.8	35 311	**199.2**
6 BRAMPTON	3 904	26.5	103 459	**1784.9**
7 BRANTFORD	2 733	24.5	66 950	**457.6**
8 BROCKVILLE	1 021	19.5	19 903	**83.8**
9 BURLINGTON	3 936	26.5	104 314	**590.3**
10 CAMBRIDGE	2 895	25.0	72 383	**600.4**
11 CHATHAM	1 758	22.0	38 685	**240.1**
12 COBOURG	642	17.8	11 421	**26.1**
13 COLLINGWOOD	635	17.5	11 114	**122.1**
14 CONCORD	SEE VAUGHAN			**142.7**
15 CORNWALL	2 023	22.8	46 121	**139.9**
16 CORUNNA	SEE SARNIA			**9.5**
17 DUNDAS	984	19.5	19 179	**184.3**
18 FORT ERIE	1 202	20.0	24 031	**174.9**
19 GRIMSBY	841	18.5	15 567	**82.4**
20 GUELPH	2 757	24.5	67 538	**779.8**
21 HALTON HILLS	1 604	21.5	34 477	**163.3**
22 HAMILTON	9 600	32.5	312 003	**1754.7**
23 KENORA	621	17.0	10 565	**24.6**
24 KINGSTON	2 345	23.8	56 032	**193.2**
25 KITCHENER	4 744	27.8	131 870	**1251.9**
26 LEAMINGTON	638	17.5	11 169	**25.7**
27 LINDSAY	726	18.0	13 062	**125.4**
28 LONDON	7 856	30.6	240 392	**1109.4**
29 LONGFORD MILLS	SEE ORILLIA			
30 MAITLAND	SEE BROCKVILLE			
31 MARKHAM	2 362	23.8	56 206	**347.7**
32 MIDLAND	650	17.8	11 568	**157.2**
33 MILTON	1 064	19.5	20 756	**249.8**
34 MISSISSAUGA	8 117	30.8	250 017	**2125.6**
35 NEWMARKET	1 227	20.2	24 795	**96.9**
36 NIAGARA FALLS	2 799	24.8	69 423	**129.6**
37 NORTH BAY	2 226	23.2	51 639	**227.4**
38 OAKVILLE	2 780	24.8	68 950	**2367.9**
39 ORANGEVILLE	675	17.8	12 021	**135.1**
40 ORILLIA	1 209	20.2	24 412	**221.9**
41 OSHAWA	3 993	26.8	107 023	**5412.7**
42 OTTAWA	9 397	32.4	304 462	**847.2**
43 OWEN SOUND	1 001	19.5	19 525	**155.4**
44 PEMBROKE	811	18.4	14 927	**32.5**
45 PETERBOROUGH	2 487	24.0	59 683	**199.9**
46 PICKERING	1 340	20.8	27 879	**227.5**
47 PORT HOPE	576	17.0	9 788	**17.0**
48 RICHMOND HILL	1 615	21.5	34 716	**321.6**
49 SARNIA	2 365	23.5	55 576	**163.4**
50 SAULT STE MARIE	3 216	25.2	81 048	**213.1**
51 SIMCOE	780	18.2	14 189	**114.8**
52 ST CATHARINES	4 535	27.2	123 351	**528.5**
53 ST THOMAS	1 308	20.8	27 206	**2079.2**
54 STONEY CREEK	1 443	21.0	30 294	**231.6**
55 STRATFORD	1 257	20.4	25 647	**307.9**
56 SUDBURY	3 725	26.2	97 604	**456.6**
57 THOROLD	812	18.4	14 944	**121.5**
58 THUNDER BAY	4 129	27.0	111 476	**388.8**
59 TILLSONBURG	553	17.0	9 404	**16.4**
TORONTO				
60 ETOBICOKE	9 170	32.4	297 109	**2764.8**
61 EAST YORK	3 991	26.8	106 950	**498.4**
62 NORTH YORK	15 425	36.2	558 398	**2157.5**
63 SCARBOROUGH	11 320	34.2	387 149	**1879.1**
64 TORONTO CITY	17 210	36.8	633 318	**2857.2**
65 YORK	5 049	28.0	141 367	**1692.3**
66 TRENTON	823	18.8	15 465	**33.1**
67 VANKLEEK HILL	128	12.0	1 539	**2.7**
68 VAUGHAN	926	19.2	17 782	**173.6**
69 WALLACEBURG	636	17.5	11 132	**73.2**
70 WATERLOO	2 045	22.8	46 623	**342.1**
71 WELLAND	1 984	22.7	45 047	**132.7**
72 WHITBY	1 354	20.8	28 173	**193.7**
73 WINDSOR	6 551	30.1	196 526	**2569.7**
74 WOODBRIDGE	SEE VAUGHAN			
75 WOODSTOCK	1 306	20.5	26 779	**442.3**

FIG 14

GEOGRAPHIC DISTRIBUTION OF EMISSIONS AND DISCHARGES,
POTENTIAL POPULATION EXPOSURES

XYLENES

5 SUMMARY

This report outlines the characteristic effects, industrial significance to Ontario and losses for specified chlorinated and aromatic hydrocarbons. It was concluded that 3 of the 17 hydrocarbons studied (chloroprene, 1,2-dichloroethylene and vinylidene chloride) were not in commercial use in Ontario in 1976.

A review of transport modes for the specified chemicals indicates that land modes were the predominant method of shipment and that neither the airlines nor inland waterways were utilized for this purpose in Ontario in 1976. Most of the specified hydrocarbons are transported by road, with rail being selected as the alternative.

The approach used to compile the emission/discharge inventory was to survey Ontario manufacturers, processors and distributors by questionnaire. Where responses were not received, emission/discharge factors were applied to 1976 volumes of specified chemical, and resulting losses were plotted on a geographic basis. Emission/discharge factors were based on literature values or calculated from responses received from the Ontario survey.

The questionnaire survey of emissions and discharges resulted in a response of 54 percent of those contacted, but only two thirds of the questionnaires returned could be considered complete and useful to the study. However, it is estimated that the useful responses covered 90 percent of the volumes produced or imported and subsequently used in secondary manufacture.

Generally, the quality of data received from chemical primary manufacturers was good while smaller companies made ball-park estimates or found difficulty in completing the questionnaires. It is estimated that total losses calculated for the specified hydrocarbons in this study have an accuracy $>$ 80 percent.

The survey enables a number of emission/discharge factors to be estimated, which were based to a large extent on measurements or theoretical calculations. In many cases they are considered the best available at the present time since comparative values could not be found in the literature. In other cases where comparative values were available, the literature values generally appeared to be high.

Based on volume of losses and population densities, the metropolitan Toronto area is most affected by the specified hydrocarbons and constitutes 27 percent of total Ontario losses. This is understandable since many of the specified chemicals have widespread public usage, e.g. dry cleaning and other solvent usage and therefore losses are related to the high population in Toronto which constitutes 26 percent of the Ontario population. The Sarnia area is the next most affected area and comprises 8 percent of Ontario losses. The effect in this area will have increased since 1976, now that the Petrosar complex and Suncor's toluene unit are in full operation. Mississauga, Windsor, Hamilton and Oshawa are also affected areas based on high population densities in a mix of highly industrialized activity where total losses of the specified chemicals are >5,000 tonnes at each location.

Based on the results of this study, there is no indication that emissions and discharges of the specified chemicals approach current preliminary estimates of hazard levels outlined in MOE guidelines and standards. However, due to the limited amount of ambient air quality data available, it is recommended that additional quantitative information be collected to enable a more accurate assessment of the situation.

The information contained in this report is applicable only for the year 1976 and any extrapolation of these data to the future should reflect the changes that are continually occurring in the Canadian chemical industry as a result of technological advances, changes in demand, or evidence of chemical toxicity.

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